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# A
# SYSTEM OF OBSTETRICS.

## BY AMERICAN AUTHORS.

EDITED BY

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VOLUME I.

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ILLUSTRATED WITH A COLORED PLATE AND THREE HUNDRED AND NINE ENGRAVINGS ON WOOD.

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# PREFACE.

THE very marked favor which has been shown to composite systematic treatises on medicine has placed the verdict of professional approval on works which realize the ideal advantages of this most attractive plan. Obstetrics, certainly not less important than any other branch of medicine, has not yet been dealt with in this manner, at least by the present generation in America. It is with great pleasure, therefore, that the Editor presents to the profession the first half of a work which will cover the entire subject of Obstetrics, and will embody the knowledge of well-recognized authorities among our countrymen whose teaching is especially adapted to our own conditions and surroundings. For the views expressed the contributors are well able to answer, and in the few instances where conflicting statements are made, it is simply an indication that there is upon those points room as yet for a difference of opinion.

In pursuance of the intention to provide the obstetrician with a complete guide to the discharge of his responsibilities, space has been assigned to departments not directly operative or therapeutic. A perusal of the first two articles will prove their eminent fitness to form an integral part of every practitioner's equipment.

Special attention has been paid to the illustrations, some of which represent the best selections from the vast literature of Obstetrics, while by far the larger number are engravings carefully executed from original sketches and photographs.

To Dr. Mann, the Editor of the *System of Gynecology by American Authors*, I am greatly indebted for the courtesy which allowed the *System of Obstetrics by American Authors* to be associated with his charge. A familiarity with the contents of both volumes now published has only strengthened a belief based on the reputation of the eminent gentlemen contributing to the *Obstetrics*, that the present work would attain the high standard set by the *Gynecology*, and that the two treatises would be recognized by professional opinion as kindred on cognate subjects.

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# HISTORY OF OBSTETRICS.

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**The history of Obstetrics possesses a peculiar interest, and one by far more general than that of any other branch of medicine, as its status and its progress are so intimately blended with the condition of the people and the progress of their civilization. The obstetric art, the assistance rendered during the act of parturition, the care of mother and child, is a necessity at all times. This branch of medicine applies to the physiological as well as the pathological state, and thus differs from all others the exercise of which is confined to morbid conditions. However remote the period, however crude or primitive the people, in ancient times or modern, aid was given childbearing woman: in the simplest cases certain manipulations were necessary, performed perhaps by the patient herself.**

The obstetric art, like that of surgery—the healing of wounds—can be traced through the earliest records, and of necessity received attention from the most primitive peoples: long before an art of medicine existed women who had themselves borne children, taught by experience, assisted their neighbors, as the warrior or the hunter, exposed to injury himself, rendered surgical aid to his fellow-man.

The obstetric and the surgical arts were the first needed, and of all branches of medicine the most capable of development, by primitive peoples dealing with parts exposed, open to view. Obstetric art, first and most frequently called for, attained a certain perfection at an early day, but not a single step forward was taken for two thousand years—from the time of Hippocrates in Greece and the Ayur Veda in India until Paré and Vesalius laid the foundation for the modern scientific school.

It was woman who gave aid to her sister in childbirth: the obstetric art was in the hands of women—women of low caste: it was looked upon as woman's work, and progress was thus impeded if not impossible. Whilst the aid of the priests, or men possessed of mystic powers, was sought for in difficult cases, they were at other times carefully excluded from the lying-in room, and thus prevented from gathering the experience necessary for progressive innovation. It was eminently the sphere of woman, and so considered until the era of modern scientific medicine. We need but recall the fate of Dr. Wertt of Hamburg, who in 1522 put on the dress of a woman to attend and study a case of labor, and was burned alive for his pains; or that of Dr. Willughby, one hundred years later, who assisted his daughter, a midwife, in a difficult labor, and was obliged to crawl into the darkened room on hands and knees. The title of mæutai—man-grandmother—was given by the Greeks in the time of Hippocrates (400 B. C.) to men called in in difficult cases; this spirit pervaded up to the scientific period, as indicated by the appellation of "man-midwife" given to Chamberlain, the inventor of the forceps, in the middle of the sixteenth century; and the adherence, even now, of the mass of the people to the midwife in the older countries, shows how deep-seated a feeling this is. During that entire era of empiricism progress was possible only as far as the eye could reach: the most important parts were concealed, the mechanism only to a slight degree exposed. Without means of penetrating or bringing to view the mystic process, actual progress was out of the question, and did not take place until the scalpel opened the way and medical men entered upon the practice of the art in the middle of the sixteenth century.

The obstetric art, beyond any one of the branches of medicine, appeals to the sympathies and to the most sacred instincts. We may look to the obstetric practice of a people as indicative of their civilization, their culture, and their morale. However crude they may be, however primitive their obstetric practice, their character is revealed by the care which they give childbearing woman. I have looked upon the rapid development of the obstetric art in France in the time of Levret as due not alone to the scientific activity of the country at that period, but equally, if not more, to the more elevated position occupied by woman. And is not the prevalence of obstetric practitioners in this country the reflex of the social status of woman? In America the practice of obstetrics was considered not alone as worthy of the physician, but as one of the most important branches of his art, and in this country confinements among native-born women have as a rule been conducted by physicians, in striking contrast to the older countries, where until quite recently, even among the higher classes, the treatment of women in labor was the province of the midwife.

During the sway of what I have called natural or empirical obstetrics, from the earliest times to 1550 in Europe, we find the status of this art a striking index to the condition of the people and entirely independent of the development of the medical science; but with the appearance of scientific midwifery this characteristic is gradually effaced, and dies out with the growing importance of anatomical and physiological knowledge: with the supremacy of the male practitioner, the scientific obstetrician, local and national peculiarities gradually fade away and the obstetric art assumes a more important position among the branches of medical science. Not until now, until this present era of scientific medicine, has it been thoroughly recognized and merged with other branches of medicine, and to-day obstetric science ranks as one of the most important branches of medicine. Yet side by side with the higher development of the art in our present civilization the various epochs of the empirical stage through which it has passed in its development still persist; obstetric art as it existed before the time of the Pharaohs, and previous to the time of Greek civilization, is faithfully preserved among races and people of a more primitive civilization: side by side with antiseptic midwifery, the perfected Cæsarean section, and the axis-traction forceps all the epochs of the empirical period are represented, to the very earliest, the primitive or intuitive practice, as it must have existed in Egypt before the times of the earliest papyrus or in Greece before the time of Homer. Among our Indians and the negroes of Africa obstetric art persists in its primitive or intuitive state, and, though the religious epoch possesses no characteristic exponent at the present day, the more advanced epoch as represented by the fathers of medicine has not yet been surpassed among the Chinese and other nations of the East, which fairly represent the progressive pre-anatomic period.

I have not adopted the various periods of time usually accepted in obstetric history, but have classified by epochs of progress, considering as *natural* or *empirical obstetrics* the art as practised from the earliest times to the middle of the sixteenth century among European nations, and still retained by nations less advanced. This is of historic interest only: the *scientific period* begins with the rediscovery of podalic version by Ambroise Paré in 1550, gradually developing with the study of anatomy and physiology and with the acceptance of the obstetric art as one of the branches of medical science, progressing as empiricism gives way to scientific research and the ignorant midwife to the scientific physician.

I have sketched only the great epochs which are indelibly characterized and readily recognized, many even now coexisting with our advanced science in the same crude state as we find them in the earliest records thousands of years ago. Less important epochs I cannot here recognize, as such minor fluctuations are without bearing upon the progress and the future of an art, and of interest only to the critical student of individual features.

Only within late years have we received a clear insight into the earlier history of obstetrics by the light of ethnological research. The study of the obstetric practice of primitive peoples of the present has lifted the veil of mystery which has heretofore clouded our knowledge of early obstetric art; recent observations serve to explain the scanty notes contained in early records, so that we now have a fairly perfect picture of obstetric practice among the nations of antiquity. The customs of primitive peoples now existing reflect the earliest practice, from which the later more refined, but by no means always improved, methods have developed.

For the earliest epoch I have drawn freely upon my work on labor among primitive peoples,[1] and dwell more at length upon these hitherto unknown methods, as there is much that is extremely suggestive in the intuitive practice of the earliest epoch, in the crude attempts to correct malposition in pregnancy, in the numerous methods of external expression, the removal of the after-birth by pressure, contraction of the uterus by heat and cold externally applied, the practical features of antisepsis which appear in the isolation of the puerpera and the thorough cleansing immediately after labor, the parching of the cord and the toasting of the maternal parts by fire; abortion resorted to to prevent an undesirable increase; in case of difficulty threatened in labor even the Cæsarean section is performed. In the very earliest epoch and among uncivilized peoples to-day we find most excellent methods, imperfect only for the want of anatomical knowledge, which have been lost in the attempted refinement of an earlier civilization. Instinct has developed the obstetric art among crude peoples to a perfection far greater than that of any of the medical sciences, and in the most primitive epoch we find methods which have recently assumed importance after their discovery and perfection by the scientific practitioner.

To the student the empirical period is extremely attractive and instructive, whilst the interest of the physician is centred upon the scientific period, the period of our present obstetric art from the rediscovery of podalic version in the middle of the sixteenth century to the present period of antiseptic midwifery with its wonderful achievements.

## I. EMPIRICAL OR NATURAL OBSTETRICS.

All obstetric practice based upon empiricism, lacking an anatomical and physiological foundation, I have considered as natural in contradistinction to the scientific. Though various degrees of refinement exist, determined by the varying civilization of the people, the practice of the obstetric art has changed but little up to the middle of the sixteenth century, the termination of this period among the people of the

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[1] Engelmann: *Labor among Primitive Peoples*, St. Louis, 1883; Vienna, 1884; Paris, 1885.

Western civilization. Among primitive peoples, ancient and modern, and during an earlier civilization, the same general characteristics prevail: obstetric practice is in the hands of women; the expulsion of the child is furthered by external manipulations and posture of the patient, aided by nauseating internal medication; during labor, and even during pregnancy, more or less crude efforts at cephalic version are made in malposition by succussion and shaking, by pressure and posture. No efforts at preservation of the child's life are made; external violence and nervous shock or mental impressions are the last resort: placental expression is practised, so also abortion. With a beginning of anatomical and physiological knowledge we find a certain refinement of manipulation; strict cephalic presentations alone are hopeful, all others abnormal, and almost necessarily fatal to mother and child; the obstetric chair takes the place of human support and posture; methods for destroying the child, embryotomy, are developed, but many of the best intuitive practices are lost.

Three well-defined epochs mark the slow development of obstetric art throughout this entire period of empirical practice, and, notwithstanding the extremes of culture and civilization and the centuries of time throughout which this has persisted, the changes practically wrought are but slight.

*The primitive* or *intuitive epoch*, the earliest and most interesting, is characterized by the simplest and crudest external manipulations, all purporting to assist the natural *vis a tergo*—all the result of that intuitive mechanical skill which we respect and admire in the products of early art.

In the second, which I have termed *the religious epoch*, very much the same practice persists, with a certain refinement, and in difficult cases the intervention of the priests, whose assistance was sought in part for the sake of the mystical powers they are supposed to possess, and in part for the knowledge and skill possessed by this learned caste.

This epoch, though still persisting at the present day, was represented in its highest development by the earliest civilization of India, of Egypt, and of Greece, and in the latter country persisted to the time of Hippocrates (400 B. C.). This is the period to which our earliest records reach. The midwife appears; surgical instruments, especially for destructive purposes, were used; and at the height of this epoch obstetric art was taught within the precincts of the temple. The importance of the different positions was known: the cephalic presentation alone was considered favorable, and all efforts were directed toward the conversion of other presentations into this by cephalic version, always recommended, but never well defined. The last resort was embryotomy.

The most advanced is the third, *the progressive, pre-anatomic, epoch,* which is the predecessor of our present obstetric art, beginning with the time of Hippocrates, and continuing, among the civilized nations of the West, to the middle of the sixteenth century. The practice is still in the hands of women, mostly uneducated, but the medical profession appears distinct from the priesthood, and is looked to for help in difficult cases. With a superficial knowledge of anatomy and physiology we see an improvement in obstetric practice, which is, however, still very primitive as compared with the remarkable development of the surgical art at that period. Anatomical knowledge had not penetrated below the surface and opportunities of study were wanting: cephalic presentations were still looked upon as the only hopeful ones; cephalic versions, theoretically taught, gave no tangible results; and embryotomy still remained the last resort. A great many instruments were invented for the purpose, and this operation was developed to the utmost possible perfection; it was the one most frequently, if not *the only one*, performed by the physician; hence it is but natural that obstetric art retained its subordinate position as a branch of surgery.

In the three epochs of empirical practice, even in the earliest, most excellent methods are more or less crudely indicated, and correct manipulations, which have been rediscovered of late by the light of our present medical science, are intuitively practised. Thus, Cæsarean section is skilfully practised by the negroes of Africa, and was known to the Israelites—the Dotze-Joffan—performed on the living, and made obligatory after sudden death during pregnancy by their religious laws, as it was likewise ordained by Buddhism, described in the Ayur Veda of Susruta. Isolation of the puerperal woman we see in the earliest epochs, both as the result of instinct and of religious laws: the Ayur Veda tells us that in India (1500 B. C.) a separate room was assigned the lying-in woman, and women of a higher caste were taken to an especial building for the purpose of confinement. In the interior of Russia a separate house is provided for the patient; the Comanches and other of our Indian tribes construct a shelter, a *wick-e-up*, some distance from the village, inside of which are two rectangular excavations: in the one is placed a *hot* stone, for steaming; in the other, loose earth to receive the discharges—perfect antiseptic practice. The inhabitants of Ceram, many of the African tribes, like those of Loango, are so confined, and are kept apart from their husbands and the villagers for weeks afterward. Intra-uterine injections were practised by Hippocrates: Polybius even attempted the artificial extra-uterine development—a process of hatching, we may say, of the fœtus after early expulsion. Now and then we find examples of prominent medical men attending important labor cases, as Antonius Musa, it is claimed, was summoned by the emperor Augustus to attend his wife Livia in confinement. Notwithstanding the wonderful perfection sporadically attained, a healthy and permanent development of obstetric art did not take place until a firm foundation was given by the study of anatomy and physiology: the discoveries of Paré and of Vesalius inaugurated the new era of scientific obstetrics, which was rapidly furthered in its infancy by the introduction of the *vis a fronte*, the forceps, by Chamberlain and Palfyn. Throughout the entire empiric period the *vis a tergo* alone was regarded: the abdominal muscles were looked upon as the moving force, and these were assisted by the hands of the aid.

### A. PRIMITIVE OR INTUITIVE EPOCH.

Of the intuitive epoch we have no historic record. It is the practice which we find among the savages of the present day, and even now rapidly yielding to the progress of civilization, most perfectly developed among the crudest peoples, who for ages have not been contaminated by contact with any of the so-called more civilized nations. Among those who are most simple in their habits, apparently most primitive, where we find an intermingling of sexes in almost complete nudity, we are likely to find the highest morality, the greatest respect shown to woman in pregnancy and childbirth, and the most perfect attention to her wants. The customs, rather than the character of the manipulations, vary with the peoples and are determined by their peculiar habits and culture.

Siebold, in his history of obstetrics, written in 1839,[1] says that but little is known of primitive practices, yet admits that some few manipulations must have existed: the cord must have been cut, the after-birth removed, and the baby dressed. Records of obstetric practice of this epoch are indeed scant, and the few references of the Bible, the teachings of Susruta (1500 B. C.), pertain to the more advanced religious epoch. But since the time of Siebold adventurous travellers have fully revealed the remarkable development of the intuitive practice among the crudest peoples—an obstetric art which will soon be lost, and is fading away before the destructive progress of our civilization, like the arts and industries of these peoples. This is as true of the natives of India and of the African negro as it is of the American Indian. With the mental and physical deterioration which naturally follows the advent of civilization, the care of the childbearing woman decreases; the same attention is not given her, the same effort is no longer made, and, moreover, the legendary intuitive practices yield to the customs of the white man, whom they imitate and whose help is sought.

These simple people, with their primitive resources, were by no means as helpless as it might appear at first sight: labor was more natural, and the patient was exposed to fewer dangers, as the difficulties of childbirth increase with the progress and civilization of a people. This is not due so much, as is often claimed, to the degeneracy of humanity brought about by softness and luxury, as it is to the danger of infection in crowded localities and the increasing disproportion of passage and passenger, changes in the relationship between head and pelvis being brought about by the mixture of races, and deformities of the pelvis by poor and unhealthy living. From dangers of infection primitive people are guarded by natural instinct, the impulse to undergo their suffering in secluded places, and the plunge into lake or stream which usually follows delivery. Deformities of the pelvis are comparatively unknown, as they are due in the main to diseases which result from the crowding of civilization; a disproportion between the fœtal head and the maternal pelvis is rare, as the intermingling of races, and even of tribes, is almost unknown; hence the formation of the head corresponds to that of the pelvis. The dangers which result from miscegenation are so well known to the natives wherever an intermarriage with whites takes place, as it does upon the borders of civilization, that the confinement of a native mother with a child by a white father is looked upon invariably as dangerous, if not necessarily fatal, as among the Indians upon the Pacific coast, the African negroes who are in contact with settlers, and the natives of the oceanic islands; hence abortion in the early months is often resorted to. The intuitive practice of primitive peoples has long since solved the problem of prophylaxis in dangerous labor which the professors of obstetric science have but recently settled, and which was seriously questioned less than one hundred years ago. In Europe and America, in our present civilization, so thorough an intermingling has taken place by the varied supremacy of different nations and their far-reaching conquests that a simple natural labor, such as we find among a tribe of primitive people, is no longer possible. A pure type of individual races and tribes no longer exists, but, fortunately, modern science by version and the forceps has more than met the difficulties caused thereby.

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[1] *Versuch einer Geschichte der Geburtshülfe*, von Ed. Casp. Jac. von Siebold, Berlin, 1839.

CHARACTERISTICS OF INTUITIVE PRACTICE.—The necessary aid in labor is rendered by women, by friends and neighbors, usually by older women with greater experience; manipulations are practised or religious customs observed during pregnancy for the preservation of the child and the attainment of an easy labor. Abortion is practised by external and even internal manipulations if for some reason dangers in confinement are anticipated or an increase of the family is to be prevented. Labor is supposed to be a voluntary act upon the part of the child, due to its desire to escape from its confined quarters; and, strange to say, this belief, existing among the Indians of the present day, can be observed in the earliest writings even in the advanced medical practice of the early civilization and more or less throughout all periods up to that of our present scientific obstetrics. The character of the labor was due to the disposition of the child: all difficulties were referable to its evil disposition. Even in France the time is not long past when the voluntary actions of the fœtus were spoken of, and when the cause of labor-pains and the expulsion of the child was looked for in the desire of the fœtus to change its condition of life—a belief which harmonizes most fortunately with the earlier epochs of obstetric practice, as it afforded good grounds for the destruction of the fœtus by efforts at expression, later by embryotomy, as a child so perverse as to refuse absolutely to appear merited death, as did the mother who carried such a child.

The main aid rendered was by the varying posture in different stages of labor, and by pressure upon the abdomen by the hands of the assistant—by kneading, shampooing, stimulation of the uterine muscles, and actual pressure to force out the uterine contents; nauseating drugs were also given to further expulsion. Fumigations with aromatic herbs were made to soften the parts, and a tardy placenta was expelled by massage by the hands of an assistant, by the patient herself, by compression of the abdomen by a belt or the end of a pole; the os is even dilated by the hands, and traction upon the cord is occasionally observed; but never is this alone relied upon for removal of the after-birth: this practice, so common among our midwives, is one of the evils of partial progress. Primitive peoples practised expression, or the expectant method, which is also known to midwives in some rural districts to-day: the cord was tied to the toe of the patient, so that gradual traction was made by extension of the leg; the same end was accomplished by attaching the cord in other ways—a truly expectant method; the patient knows that something is being done, and Nature will in time act. Contraction of the uterus post-partum is accomplished by kneading, by spraying of the abdomen with water skilfully thrown through the teeth or from a jug, and the cleansing by a plunge into the neighboring stream, always possible, as the border of a lake or the bank of a river was the favorite place for women in search of a solitary confinement, and the early habitations were all near the water. Even the binder is used here and there among primitive peoples, known as the squaw-belt among the Sioux tribes, applied either before the expulsion of the child or of the placenta, and worn until the next day. The Kiowas and Comanches wear a broad bandage of buckskin, which is applied immediately after the completion of labor and is worn for about a month. In Old Calabar a handkerchief is tied around the abdomen, the knot being placed over the hard contracting womb.

Various practices exist as to the period of rest during the puerperium: some return to their ordinary occupation the moment they escape from the scene of the labor or immediately after their plunge into the water; but among many peoples there is a certain time of rest and isolation, which becomes more thoroughly defined as the religious epoch is approached, an intuitive belief in the uncleanliness of the menstruating and puerperal woman existing, which takes shape in the religious idea of uncleanness. A period of rest is given the young mother by the unwritten laws of the people, and accorded her by religious authority in the more advanced epoch, during which she can attend to herself and her child. Some of our Indians seek to cleanse themselves by frequent steaming, others by washing; the Siamese and others, by a purification by fire. Among the Kalmucks the woman is regarded as unclean for three weeks after delivery, but never permitted to remain in her bed longer than seven days. The northern tribes of Russia, the Samoyedes and others, consider the puerpera unclean for several months after confinement, and after the expiration of two months she herself and the tent in which the confinement took place are thoroughly smoked, and from that time on considered clean. Is this not antisepsis in advance of private obstetric practice of the present day, and equal to that of the best-regulated maternity?

With regard to the umbilical cord, very much the same difference of practice exists in this intuitive epoch as it does at the present day: heat is frequently used, and to a most excellent purpose, to purify and further uterine contraction. The Rouconyennes woman takes a steam-bath in a hammock, and under this a large hot stone is placed, upon which water is thrown; the Annamite has a vessel filled with hot coals placed under her bed, and a fire kept going night and day, the stomach being rubbed twice a day with a vessel filled with hot coals. A pot of charcoal is placed at the door of the house on the end of a long pole as a sign of labor, and *entry is forbidden to those whose labors have been difficult or in whose families death has attended labor.* (Do we at the present day, in our most civilized communities, do as much to prevent the danger of infection?) The puerpera in Annam takes a decoction of laxatives and purgatives, and during the month of her childbed her husband abstains from all work and must give his attention to wife and child; the mother cannot leave the house before four weeks.

Intuitive practice, like that of the most learned obstetricians, varies with regard to the time of cutting the funis and the length of the remnant to be left. As a rule, the cord is not severed until labor is completed and the secundines are expelled. In the more advanced practice, until recent researches proved the harm to the child, the cord was cut and tied immediately after expulsion. Among many of our Indians and the Sandwich Islanders the child remains on the ground in front of the mother until the placenta is delivered. Among the Kiowas, Comanches, and others the assistant takes the cord between her fingers and squeezes such blood as may remain in it back toward the placenta, and not until then is the cord cut and tied. The Flatheads, Crows, and Creeks cut the cord at once. The natives of Syria wait twenty or thirty minutes before cutting the cord, but if the after-birth is not expelled by that time, it is severed and the patient put to bed; the Wakamba, in Africa, use threads of the bast of the monkey-bread tree, and tie the funis tightly two or three inches from the navel; the Mexican Indians, some three inches; the Comanches tie it about a foot from the body of the child. The Waswahili of Africa leave the cord very long and allow it to dry slowly; the Loango of Middle Africa cut it short and dry it rapidly, severing it at double the length of the first joint of the thumb, after which the child is taken to the fire and the remnant of the funis steadily pressed by the warm fingers of the attendant so as to hasten its drying, which is completed in twenty-four hours; then the withered mass is forced off with the thumb-nail and burnt. (A better practice than that now prevalent, and corresponding to the most recent antiseptic treatment of the cord by Dorhn.) The Syrians tie both sides; the Blackfeet ligate the fœtal end, but take the precaution to pinch the protruding placental end of the funis with the fingers, so as to prevent oozing. Dull instruments are usually used for cutting the funis, a bruising and crushing rather than cutting, thus preventing hemorrhage; the Klamath and other Indians chew off the cord. These customary procedures, now traditional superstitions, must have originated in some thinking mind, and good reasons have existed for their use.

In the management of the after-birth the superiority of primitive intuitive practices over all later refinements is well marked: the Australian woman squats down, in a small excavation in the ground prepared for that purpose, as in defecation—a favorite position among primitive peoples at this period of labor, as many of the muscles come into play which serve in the expulsion of the feces; the Sioux compress the abdomen with a belt; other Indians and some of the negroes of Africa use massage or the shampoo, and almost all manual expression.

Now, let us compare with this the practice of people more advanced: in Galicia the midwives do not bother about the after-birth, and cases of retention and putrefaction are common; in Persia traction upon the navel-string is frequently practised, so also in Palestine, and if the placenta does not readily approach the orifice, the cord is tied by the aid of a string to the patient's toe and the child is wrapped up and kept warm until the placenta appears; the Chinese follow a similar method, attaching the cord with a string to the patient's hip; in Caledonia it is tied to the patient's toe, as it is thought that the stretching of the foot will then draw out the after-birth. These are the milder and more harmless forms of traction as practised also in the primitive epoch, but among the somewhat more advanced peoples a more forcible *vis a fronte* is commonly resorted to; the manipulations and methods for hastening the expulsion of the after-birth are more dangerous, and more liable to lead to retention. In China death is frequently the result of the forcible dragging out of the placenta by the midwife, whilst inversion and prolapsus are frequent in Russia. The untutored, simple-minded savage, although crude in the methods he pursues, obeys a correct, even if we should term it an animal, instinct, and approximates more closely to the teachings of the science of to-day. Among people of a certain civilization a more harmful method is resorted to—the dragging out of the after-birth by the funis—and the midwives of our great cities either follow the same pernicious habit, or, like the natives of Galicia and such border provinces, leave it in altogether if nature or their own dangerous traction does not readily produce it. The ordinary class of educated midwives of to-day still resort to nauseating drugs; in Russia warm water is given to cause vomiting; in Germany the patient is made to cough, to breathe into the hand; the braided hair of the patient or a finger is placed in her throat by the Greek midwife. In Mexico vomiting is caused to aid expulsion.

Compare with this the simple, effective, and harmless practice of expression which is most common in the intuitive epoch—friction of the abdomen and steady pressure; the Makah Indians even assign this important duty to an especially skilled person, whose special practice is the delivery of the placenta.

Ten lunar months are usually calculated as the period of pregnancy, which is recognized by the suppression of the menses, by the enlargement of the abdomen, and the appearance of reflex neuroses, such as freckles on the face, varying appetite, the flow of saliva, or swelling of the neck. Particular care is taken among many primitive people of the pregnant woman; others prepare more especially for labor, for the easy expulsion of the child: thus upon the isle of Jap, in West Mikronesia, they begin to dilate the os at least one month before delivery is expected; the leaves of a certain plant, tightly rolled, being inserted into the os, distend when moistened by the uterine secretion, after which a thicker roll is introduced, dilating the mouth of the womb to make labor more speedy and less painful.

I cannot detail all the numerous and varying practices,. many of which may well serve as a guide at the present day.

In labor proper the greatest effect is achieved by the posture of the patient and by external manipulations. The women of the various tribes and races are delivered according to customs, and in positions, which are peculiar to their people whenever they are free to follow their own instinct. The same woman often assumes various positions in the course of a natural labor: more at her ease in the early stages, she takes the position in which she is confined when the pains become more regular, rapid, and severe; in the last stages of ordinary labor the inclined positions are more frequently resorted to. In all positions, whether the patient is swinging by the limb of a tree, whether she is kneeling by a stake or semi-recumbent in bed, there is a decided change in the axis of the body during the pains and in the interval of rest, and usually the patient has a support of some kind within reach—a rope, a stake, or an assistant—by means of which she can change and intensify the action of the voluntary and involuntary muscles during the pains. In tedious cases, when delivery is retarded and labor will not advance, a change is usually made in the posture of the patient and massage is freely resorted to. A position frequently assumed is the semi-recumbent, seated upon a low stool or upon the lap of an assistant, as it was the custom of the Greeks, as we see it indicated upon the old Peruvian funeral-urn from the time of the Incas, as it is practised alike by some of our Indians, by African tribes, and by villagers in the country districts both in Europe and America. With the advance of the obstetric art the support given the parturient woman by the bone and muscle of her kin, by husband, or by tenedora was replaced by a form of wood;[1] the thighs upon which she sat, the chest against which she rested, were replaced by the cut-out seat and the slanting back of the obstetric chair, which was formed so as to receive the patient in the same position which she was wont to occupy on the lap of a fellow-being. But the support which was given the perineum by the underlying soft part (the lap of the holder) or by a mound of earth or sand when seated upon the ground (as in Africa) was lost with the advent of the obstetric chair. The external manipulations were of the most various kinds: kneading of the abdomen, massage, or shampoo; then simple expression, either by the encircling arms of an assistant or her hands placed upon the abdomen—the most simple and common form of pressure. This living compressor may be replaced by a bandage the ends of which are in the hands of an assistant, or the patient is suspended by a rope and the uterus is stripped down by the weight of an assistant, who hangs upon the abdomen of the sufferer. Truly uncouth is the method of expressing the ovum by a weight placed upon the enlarged abdomen or by the feet of the assistant, who tramples upon the back or belly of the patient. The patient even assists herself by tightening a belt, by leaning with the uterine fundus against a staff firmly placed in the ground, or by lying upon the floor with a pillow under the abdomen. Then, again, efforts are made to shake out fœtus and placenta, the midwife or assistant raising the patient by her arms and shaking her as she would a sack, allowing her to fall, partially catching her with a shock, so as to force out the uterine contents. In Mexico and Southern India she is shaken several times to promote delivery, but if this does not answer she is rolled upon the ground or suspended by her feet and shaken. The object of this procedure, which is resorted to after the failure of downward pressure, when it is evident that the child cannot be expelled in the natural way, is evidently to throw the fœtus out of the pelvis proper into the roomier upper portion, so that it may change its position and come with head or feet first. The Nez Percé Indians reverse the patient if labor is prolonged, and whilst the head rests upon the ground shake the body vigorously in the air; then they again lead her to the stake and see if the condition of affairs is at all improved; if not, the process is repeated. The Esthonians suspend the patient whilst shaking her vigorously if labor is retarded. In Syria she is packed in a blanket if she is not confined within twenty-four hours after the commencement of labor, and four male or female friends seize its corners, rolling the poor woman about in various directions, occasionally bouncing her up and down to facilitate confinement.

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[1] In the seventeenth and eighteenth centuries, even in the beginning of the nineteenth, it was the height of obstetric ambition to devise some improvement in the obstetric chair, and in some countries, as in Turkey and Syria, it is still one of the important factors in labor, a prosperous midwife carrying her own chair from house to house for her patients.

During pregnancy massage and shaking are used to correct supposed malpositions or to produce abortion, as among the Piutes, the natives of Australia, the Loango negroes, and others. Abortion is also inaugurated by firmly kneading and rubbing the abdomen with the hands, or by pounding and working it with the fists, either for criminal purposes or because the often-fatal labors with half-breed children are dreaded. In India and in Africa abortion is often produced when the mother is suckling one infant and finds herself pregnant with another. It is evident that in the primitive epoch abortion is practised to avoid labor at term by which life or health of the mother is endangered.

Massage, kneading, and shaking serve during labor for the correction of malpositions which are supposed to exist if expulsion does not take place in proper time, the same external manipulations being resorted to in the third stage if the placenta does not readily appear. Forgotten by civilization for ages, these practices have only of late years again been accorded the importance which simple-minded primitive peoples have always conceded to them.

### B. RELIGIOUS EPOCH.[1]

Of this epoch we have historic record at the time of its highest development only, in early Egypt and India, when it gradually merges into the third or progressive period with the emancipation of the medical sciences from the temples, as in Greece at the time of Hippocrates. To-day this epoch is exemplified only in its earliest stages, a primitive practice guided by religion, as, for instance, among the Appalachicola Indians, the Bashkirs, and certain of the Arab tribes. Not alone amongst some of our Indians, but amongst other of the uncivilized peoples as well, religious incantations are relied upon to conquer the evil spirit which is rendering the child obstreperous and unwilling to proceed in its passage: the very earliest period of the religious epoch still persists, but the culmination, as represented by the rising power of India and of Egypt, belongs to the past only. The priesthood, the sacrificers to the sun, practised medicine to the exclusion of other castes and assisted in difficult labor. Thus, in Gaul and upon the Britannic isles the Druids, who were priests and legislators, shared exclusively with their women this prerogative.

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[1] I have adopted the term "Religious Epoch" for the purpose of characterizing an obstetric practice, purely empirical, in the hands of women, aided in difficult cases by

In Egypt, as recorded by a papyrus still in existence, from a time 3500 B. C.,[1] and in India, as told in the Book of Life, the Ayur Veda, in the period of Brahmanism, 1500 B. C., this epoch was at its height, and obstetric art attained a perfection equal, and even superior in many points, to the later progressive period, in which the physician first appears.

Labor is in the hands of midwives; aid is sought of the priesthood in difficult cases, who in the earlier period beseech divine interference, and in the later actually render effective assistance; surgery and surgical obstetrics being practised and taught by them, external manipulation is resorted to; instruments for the purpose of embryotomy begin to appear; the priesthood, with a certain knowledge of anatomy and of medicine, by manipulations, by internal remedies, more especially cathartic and nauseating, and by mental impressions, overcome many of the difficulties of labor; podalic version is even known; religious laws dictate Cæsarean section upon the dead; and a proper care of the pregnant, and especially of the unclean puerperal, woman; but the death of the child, embryotomy, is the last resort. The abdominal muscles, the *vis a tergo*, aided by the hands of an assistant, are the main agent in the expulsion of child and after-birth.

The religious atmosphere which pervades the medical and obstetric practice in the historic period of this epoch is shown by the innumer-

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the priesthood. In the earlier periods of this epoch it is the medicine-man, the devil-seer, or the priest who dispels the evil spirit; but with the progress of knowledge, which emanated from the temple, an obstetric art is developed within the sacred precincts, so that in the more advanced periods medication, manipulation, and surgical operation take the place of prayer and incantation. The next step is the emancipation of the medicating priest from the temple, and we have the perfection of pre-anatomic obstetrics and the physician as consultant.

[1] Haeser: *Grundriss der Geschichte der Medizin*, Jena, 1884.

able deities which were supposed to preside over childbirth, by the combination of religious and medical teaching, and by the appearance of obstetric precepts in religious laws. In Egypt the greatest medical school was in Memphis, with the temple of Imhotep, the Egyptian Æsculapius: medicine was combined with the service of the gods; the sick went to the temple for their physician, and their fee was a gift to the gods. The Greeks had many gods and temples: Æsculapius and his daughter Hygeia were the deities mainly looked to as preservers of health, and innumerable were the pilgrims to their shrine. Roman mythology especially is resplendent in obstetric deities: Lucina is the same as the Greek Eileithyia; we have a Juno and a Diana Lucina, who are supposed to preside over labor, but each separate act and function had its particular deity; the Carmentes Prorsa was called upon in cephalic presentations, and the Post-vorta in malpositions; then we have deities of the puerpera and deities for the infant in its cradle—one for the process of nursing, one for the development of the body, and innumerable others, even to Mena, the goddess of the monthly flow.

The religious teachings of the Israelites touched upon sexual practice, conception, and pregnancy, as was the case in early Mexico. A papyrus now in the Berlin Museum dating back over three thousand years B. C., claiming to be a copy of one still older, records the signs of pregnancy and tells of remedies to further conception. The Zendavesta of Zoroaster indicates the prevalence of religion in the early medical practice of Persia.

Little is known of early Egyptian obstetrics, notwithstanding the wonderful development of other specialties which were properly looked upon as pertinent to medicine. As the medicine of the Israelites sprang from that of Egypt, we have among those people the same religious aspect, and the high regard for cleanliness which is evinced by all Jewish teachings pervades the little that is known of their obstetric practice. The Cæsarean section (Dotze-Joffan) is ordained both upon the dead and living when delivery ceases to be possible; sexual intercourse is limited, and the puerpera guarded. The practice was altogether in the hands of the midwife, the *myelledith*, as she was called by the Jews.

Our most complete knowledge of obstetric practices of this period we owe to the Ayur Veda of India, the Book of Life, the precise date of which is unknown; credited to Brahma himself by some, it is supposed by others to be mainly drawn from Hippocrates. It certainly appears to be a compilation from various sources, written at various times.

A good idea of the presentations of the fœtus exists: ordinary labor is looked upon as a natural mechanism to be cared for by the midwife, whilst the physician skilled in surgery is to be called in difficult cases; eight abnormal positions are described, the fourth of which is with the trunk of the fœtus, side, or back over the os, to remedy which podalic version is recommended; the pushing up of the posterior part and bringing down of the anterior into the os, after which extraction should follow. As the literature of India was but little known, this suggestion is lost, and in later times we hear nothing more of podalic version until mentioned by Celsus and Soranus. The most important cases of dystochia were deformities of the head and pelvis and malposition: cephalic presentations alone were looked upon as normal. The fœtus when dead was cut up if it could not be otherwise removed, and Cæsarean section was at once performed after death in pregnancy. The tardy placenta was removed by pressure, by shaking, and by vomiting. Women of a higher caste were taken to an especial building for their confinement; a separate room and isolation were even accorded those less favored by fortune—a result of that cleanliness which we find instinctively governing in the intuitive practice of primitive periods, and which receives such thorough recognition in the priestly teachings of the religious epoch in India, among the Israelites, and the ancient Mexicans. The puerpera does not leave the house until after the sixth week. The care to be taken of the child is minutely described: the breast is given for six months, then the child is fed on cow's milk, and up to the fifteenth year on rice and milk.

We can hardly wonder at this advanced obstetric teaching when we see laparotomy performed for intussusception, and know that the intestinal suture was practised and rhinoplastic operations were performed.

Notwithstanding the prevalence of religious teaching and the high civilization of India under the sway of Buddhism, I hardly know whether to look upon the obstetric practice of this period as belonging to the religious or to the more advanced epoch: while the caste of the physician and the priest, at first one and the same, remained nearly allied, the surgeon is especially mentioned as a consultant in difficult labor cases. Our knowledge of Jewish medicine is derived from the books of Moses and the Talmud, and whilst the care of the sick devolved upon the priesthood, it gradually fell to the lay members, certain of whom devoted themselves more especially to the study of medicine. So also in Egypt with the high development attained by medicine, which had its origin in the temple, the identity of the physician and priest was soon severed; and Homer already speaks of the physicians of Egypt, saying that the Egyptians are of Pæon's tribe, and every one is a physician: the study of the specialties attained a perfection unequalled until this nineteenth century, but obstetric practice was in the hands of the midwife, and the surgeon was consulted in difficult cases mainly for the purpose of performing embryotomy. In India, in Egypt, and in Greece it was the learning and high culture of the priesthood which led to the development of medical science: gradually a separation was effected, yet the precise period of time cannot be given.

Though this was an epoch little favorable to the development of the obstetric art, great good was accomplished by the intervention of religious laws, as it was possible only in such an era of devotion to the deity. Thus, cleanliness, above all, is preached by the laws of the Jews, the Talmud especially dealing with sexual practices, conception, pregnancy, and labor; and whilst the religious tendency of the art may be traced to Egyptian influence, it was Greek medicine which dictated these correct precepts, as wise and full of forethought as was the law of circumcision. Similar were the teachings in ancient Mexico. Whilst in India medical men became established as a caste separate from that of the priesthood, and in Greece even before the time of Hippocrates the connection between the temple and medical teaching had ceased, the masses still sought relief from the deities in prayer, and this service of Æsculapius continued up to the fifth century after Christ, and still later, carried on by the Christian Church when this took the place of the heathen temple.

The state of affairs was much like that now existing among the lower classes in civilized countries. The attendant upon childbearing woman—the mæa, grandmother, of the Greeks, or mæutriæ, when a professional midwife—was accused of precisely the same failings which we find among that class to-day: she was known to produce abortions, and surpassed her sphere by engaging in the treatment of the sick, especially sick women. Thus we know among others of Aspasia, the midwife mentioned by Aëtius, that she was said to excel in curing disease. In Athens, the midwife, in order to practise her profession, must have had children and herself be past the menopause.

### C. THE PROGRESSIVE PRE-ANATOMIC EPOCH.

The practice of midwifery continues unchanged, with but little variation from the time of Hippocrates, in the fourth century before Christ, to the revival of learning in the middle of the sixteenth century, and the teachings of this great master characterize the status of the art throughout that entire time. (The writings of Hippocrates, as now known to us, like the Zendavesta of Zoroaster and the Ayur Veda of Susruta, undoubtedly have not all come from that one great teacher, but we need not here consider the authorship of individual parts, which may be ascribed to his sons, Thessalus and Draco, and his son-in-law Polybus, or even to later times; even Galen complains that the kings of Egypt and Pergamos in the third century B.C. caused much confusion by placing in their libraries such compilations as coming from Hippocrates himself.) In his books, *De Morbis Mulierum* and *De Superfœtatione*, we find most of the obstetric teachings; but in his *Aphorisms* and in other of his writings, which are certainly not genuine, important data are furnished.

The care of childbearing woman is in the hands of the midwife, labor being looked upon as a normal mechanical act: the physician is summoned only after the death of the child for the purpose of destroying and removing it—for the performance of embryotomy. Head presentations are the only natural and hopeful ones: all others are unpromising and must be corrected by cephalic version, whether the child be living or dead. The methods by which this is accomplished are vague—usually external pressure, concussion, and internal remedies which produce vomiting and sneezing. Hippocrates speaks of cephalic version, yet neither he nor those after him give a definite practicable method; hence, whilst advocated in theory, execution was almost impossible, and embryotomy remained the only resort, and the work of the physician was limited to embryotomy and the expulsion of the retarded placenta. The latter is accomplished by slight traction on the cord (far inferior to earlier and more primitive practices). The first obstetric instruments make their appearance, and these are of course those needed by the surgeon for the cutting up of the child: three distinct instruments are described by Hippocrates. The obstetric chair was employed; in more primitive epochs the kneeling and sitting postures were common in childbirth, but in the time of Hippocrates women were confined in bed and in difficult cases on the obstetric chair, which is a refinement of the sitting posture in the lap of an assistant. Labor, as among the most primitive peoples—among our Indians, the Russian mountaineers, and the Chinese of to-day—was supposed to be an effort on the part of the child itself, and any hindrance in its progress was due to its own evil intentions. The pains were explained by expansion of the symphysis, and expulsion was furthered more by irritating pessaries and bloating food and concussion than by the more effective methods of pressure adopted in earlier epochs: with the progress of civilization many of the simple intuitive practices are lost. The one progressive step is the fairer prognosis of footling cases. The sexual organs are well described as far as the eye and hand can reach; the ovaries are not mentioned. A thorough knowledge of the methods of preventing and furthering conception is evinced: the tamponing of the os is described. Malpositions of the uterus and the large fatty abdomen are named among the conditions preventing conception: advice is even given how to produce male or female children. Methods of producing abortion are fully understood —a practice which we find also in the earlier epochs. A separate paper exists upon premature labors in the seventh and eighth months, those in the seventh month being considered the easier and more promising— a belief which continues to the present day as a popular superstition.

Later writers often state that whilst children at the seventh month are viable, those at the eighth month are not.

Better teachings than those found in the works of Hippocrates were impossible with the limited knowledge of anatomy possessed at that time. The Greek religion made progress in this direction impossible, and the customs of the people, as well as the spirit of the times, forbade closer observation of the living woman, thus most effectually checking the development of obstetric art. Podalic version was unknown: cephalic version, in all cases in which the head did not present—that is, in all malpositions—was recommended in theory, whilst its execution in practice was almost impossible with the crude methods known: hence embryotomy remained as the only and last resort in all but simple cephalic presentations—in labor under normal conditions: to this the work of the physician was limited, and for this alone the physician was summoned, if not to remove the tardy placenta. Traction on the cord, the method by which the afterbirth was delivered, is so crude that death from a retained and sloughing placenta must have been common, and it seems but natural that the public withdrew more and more from the male practitioner who brought only death and destruction, with embryotomy for the child and traction upon the cord for the placenta as his only help: thus the opportunities for study upon the living were gradually withdrawn, whilst upon the body of the dead they were impossible.

Such was the status of obstetric art for two thousand years amid the nations of the Western civilization, and for double and triple that period of time among those of the East. Whilst in China and Japan similar practices must have existed long before the time of Hippocrates, no progress is visible, and obstetric art has persisted unchanged from that day until this, yielding in the larger cities only to the scientific practice of our present civilization as carried on by European and American teachers.[1] Hippocrates had carried the art to such perfection as was possible without anatomical knowledge, and suggests much that is valuable which was lost at a later day. We should suppose a certain perception of the origin and importance of puerperal fever from the knowledge of intra-uterine injections and the danger of the cessation of the lochia: many of the reflex neuroses as symptoms and results of pregnancy were recognized: puerperal mania is described by Hippocrates as one of the numerous reflex nervous conditions which this keen observer so clearly describes. The ancients fully appreciated the increased susceptibility of the nervous system of women during pregnancy and in the puerperium: the law in Carthage and in Athens forbade the pursuit and punishment of a criminal or murderer who sought refuge in the home of a woman who was pregnant or had recently given birth to a child.

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[1] In [illegible] the first school for midwives was established in India.

The perfection of obstetric art followed in the wake of the most progressive civilization, and thus we find, after the decline of Greek power with Alexander the Great, the most advanced practice again in Egypt, in the school of Alexandria under the Ptolemaiei, which retained its prominence almost up to the time of the Christian era: in this school opportunities were afforded for anatomical study, and vivisections were even made upon the bodies of criminals. Herophilus and Demetrius were amongst the most prominent obstetricians of this time, the latter already indicating footling cases as among the least unfavorable of the abnormal presentations. Shortly before the Christian era Greek physicians began to come to Rome, and it was here that the classical teachings of Hippocrates were perpetuated by Celsus (30 B.C. to 14 A.D.) and Soranus (under Trajan, 98 to 117 A.D.), by Galen (131) and Aëtius. For a brief period of time the Alexandrian school stood pre-eminent, until the rising power of Rome created a new and more healthy civilization, which attracted learned men from the decaying monarchies of the East.

A. Cornelius Celsus, a descendant of one of the first families of Rome, though mainly a compiler and following the teachings of Hippocrates, indicates a certain progress in the obstetric art. Like those before and after him, he treats of the obstetric practice as a branch of surgery in that part of his medical writings, "*Quæ manu curet.*" He accepts four positions, head, breech, foot, and shoulder: the assistance to be rendered by the surgeon is version, podalic and cephalic, manual extraction after version, or extraction with the sharp hook and embryotomy; the latter operation is more fully discussed and many instruments are given. Podalic version is mentioned, though, strange to say, only in case of a dead fœtus, and, contrary to Hippocrates, the better prognosis of foot presentations is dwelt upon.

With Celsus obstetric art progressed, but attained such perfection with his follower, Soranus, that it would appear that some prominent workers must have intervened whose writings have been lost, and so it seems from the reference of Soranus to authors of whom we are in total ignorance.

Soranus in his work *Peri Gunaikaion Pathon*, addressed to midwives, records much which has been ascribed to Philumena, Moschion, and Aspasia. The causes of dystochia are in the mother, in the child, and in the sexual organs. In the mother they are physical and psychical; sorrow or joy, peculiar mental conditions, and epilepsy are looked upon as reflex nerve-influences. The physical causes are dyspepsia, anorexia, dyspnœa, diarrhœa, and a fat body. Soranus teaches podalic version to save the living child, though Celsus already says that the feet should be seized if they are near; and upon this slender foundation is based the claim made for him of having practised podalic version, which he advocates only when the fœtus is dead. Soranus is the first in this period to teach podalic version before the death of the child; and if this is impossible, he, like all others, resorts to embryotomy. Both Celsus and Soranus give much space to this, at that time, most important of all obstetric operations.

The teachings of Soranus mark the highest development of the obstetric art in the ancient civilization of the West; fathered by Hippocrates, fostered by Celsus, it was perfected by Soranus, with whom independent original work and progress cease for fifteen centuries. The only credit due later authors to the end of the fifteenth century is the preservation of the greater part of the earlier achievements. Even as the dawn of light approaches, the obstetric chapter in the surgery of Guy de Chauliac depends upon Aëtius, and the teachings of Savonarola are referable to Soranus.

In the *Inaugural Dissertation* of Paul Goerlitz, Berlin, 1873, the work of Soranus is well analyzed, and he is given precedence over all ancient writers for the following reasons:

1. His fair, generally correct, knowledge of the female sexual organs, the separation of uterus and vagina.
2. He anatomically defined the positions of the child.
3. He taught that nature completes normal head and foot presentations, and that breech, knee, and incomplete foot presentations must be converted into complete foot presentations (all previous writers considered only cephalic presentation as normal).
4. He defines the causes of the partus difficilis well.
5. He clearly defines the indications for operative interference. He gives excellent advice as to the position to be occupied by the parturient—in simple cases, on the obstetric chair or in the lap of an assistant; in difficult cases, the recumbent position in bed: expression by pressure on the abdomen is recommended, and dilatation of the os if needed. Most important, and neglected at the present day, are the rules laid down for the hastening of labor or the improvement in the presentation or position of the child by change of posture: the conditions under which the kneeling, the dorsal, or the inclined, or the right or left recumbent position, is to be assumed are precisely indicated.
6. Great stress is laid on internal examination, which is recommended for the detection of malposition and the progress of labor.

The operations described are podalic and cephalic version, extraction by the feet, changing of imperfect to perfect foot presentations, cephalotripsy, embryotomy, and even the accouchement forcé.

It is the influence of Soranus which has extended throughout the Middle Ages. His treatises on the management and feeding of infants, the gymnastic manipulations of the child, the choice of wet-nurse, are most excellent, and more complete than we may find them at the present day. Percussion and succussion are utilized for purposes of establishing a differential diagnosis between molar pregnancy, tympanites, and ascites. The dioptera or vaginal speculum, which is represented upon the papyrus and the obelisks of the Egyptians, is utilized by Soranus in gynecological treatment. Women with broad shoulders and small hips are indicated as liable to difficult labor. He is the first to reject false measures and to limit embryotomy, which was possible, since all abnormal positions were to be changed by version into cephalic or podalic.

Moschion, during the time of Hadrian, 117 to 138 A. D., has written a work for midwives in imitation of Soranus, containing little that is new, though more definite directions are given for terminating podalic presentations, which he, however, says nature can complete.

Claudius Galenus of Pergamos (131–210 A.D.) presents an excellent compilation of the obstetric teaching of that time, and whilst the work of Soranus prevailed throughout Europe until the Middle Ages, the teachings of Galen extended to the Byzantine empire and to Persia, and thus to the Arab conquerors.

The works of the sixth and seventh centuries mainly consist of abstracts and compilations of the teachings of Galen.

Obstetric art, with the sciences, recedes during the gloomy period of the third and fourth centuries, when Roman culture succumbed to luxury, effeminacy, and vice; but, fortunately, with the spread of Christianity the earlier obstetric teachings, with the works of science, were preserved in the convents, which at least retained for the future, if they did not utilize or develop at the time, the teachings of the past.

The collective work of Aëtius, while adding nothing of value, contains many errors not in Soranus; his expression is less clear, his material not so well arranged, and he still follows the erroneous idea of a female pelvis united by yielding bands, whilst he looks upon the male pelvis as a solid structure; and his operative chapters clearly show the retrograde tendency.

The compilations of Paulus of Ægina of the seventh century are well known, but bring nothing new; in the main, he follows Aëtius, and so may be traced to Soranus.

The obstetric art, developed by Hippocrates in Greece, followed the course of civilization to Alexandria, and later to the East and to the West: it was carried by Greek exiles to Persia, and thus reached the Arab conquerors; in the West the rising power of Rome attracted the learned men of Greece. With the Greek physicians the obstetric practice of Hippocrates reached Rome in the first decades of the Christian era, and attained its greatest perfection with Soranus and Galen; after them, with the fall of the Roman empire, came a period of darkness, and art was lost, yet the teachings were preserved in the monasteries of Christian Europe, and buried there.

The practice of the obstetric art was continued by the Arabs, who received their knowledge from Greek physicians who, for the sake of their religion, had fled to Persia: as conquerors of India, the Arabs came into possession of the Ayur Veda, thus adding the treasures of the East to those of the West. Yet obstetric art was not advanced by this warlike and nomadic people: notwithstanding the advantages obtained and the development of the sciences, the teachings received were not even utilized. In Spain and in Sicily in the thirteenth century Arab culture attained its height, and thus the learning of Greece and of India was brought to mediæval Europe, where Roman knowledge was slumbering in the monasteries, and light was soon to break over the darkness which had so long prevailed.

Among the Arabs obstetric practice was completely controlled by women, by midwives, who even performed embryotomy and decapitation: the treatment of sexual diseases, of women and of men as well, was in the hands of females. Their most prominent medical writers are Serapion, Abul Kasim at the end of the tenth century, Eben Sina (Avesina), 980 to 1037, and Abul Caser, 1120.

The isolation of women and the religious customs of the Arabs were a check to the progress of obstetrics. The teachings of Galen were mainly followed. Version is mentioned in a vague manner, without any explanation as to the method of performing the operation. Footling cases are classified among the abnormal and dangerous, and embryotomy is developed to its fullest extent. The obstetric art of the Arabs is the most deadly and bloody of all: the physician, deprived of every opportunity of observing woman in labor, is summoned only in the moment of extreme peril for the purpose of performing embryotomy. The aid given by the midwife is by the obstetric chair, by inunctions, fumigations, injections, succussion, and remedies which cause sneezing. Concussion, pressure upon the abdomen, and rupture of the membranes are taken from Aëtius.

The obstetric art was not enriched by the Arabs, unless we may consider their numerous embryotomy instruments an improvement, and the many remedies for the purpose of mitigating labor which were brought from the East when the Arabs had learned the use of medicinal plants. On the contrary, the custom, which had been well established by Celsus and Soranus, of summoning the aid of the physician in difficult cases had died out, and obstetric practice was entirely in the hands of women.

During the Middle Ages, after the downfall of Rome, from the sixth to the sixteenth century, darkness prevailed in Europe. Science and art were dissipated by the storms of internal dissension and strife and by the incursion of barbarian hordes from the East: the isolated efforts of struggling knowledge were crushed by the power of the Church, and the clergy zealously retained the gathered learning within their convent-walls as a sceptre with which to sway the masses, which were kept in the darkest ignorance. The teachings of able men were lost or laid aside, and replaced by ridiculous theories and methods which originated in fanaticism and grew upon the ignorance of the people.

This is the most unfortunate period in the history of obstetrics. Complete ignorance prevailed, without the intuitive skill of the primitive epoch, and without the knowledge of the previous civilization: deprived of the aid, however poor, of the male practitioner, the practice of the Middle Ages presents the accumulated evils of previous periods aggravated by ignorance and barbarism.

The fate of childbearing women throughout the European continent was in the hands of the lowest and most ignorant of females. One of the first indications of the coming change was the education of women for the practice of obstetrics in the school of Salerno, and in 1468 Savonarola of Padua gives the first evidence of the return of the physician to the practice of obstetrics, but the midwife continues to operate, and the duties of the physician, when called, are only to medicate; yet the presence of the male practitioner under any circumstances is a beginning. Dancing is mentioned as an aid to labor. Women are confined in a standing or kneeling posture, whilst the midwife presses the abdomen or dilates the parts with the oiled hand. Cephalic version and the possibility of podalic extraction are accorded a few brief passages, which constitute the only mention of these operations for centuries. Yet light is dawning: in the thirteenth century anatomical research begins; one body in five years is allowed and ordered for dissection at the University of Salerno; in the fourteenth century anatomical studies were permitted at Montpelier; in the fifteenth century at the universities of Prague, of Vienna, and of Tübingen. From the Church of Rome came a powerful stimulus to the development of the obstetric art: the penalty of eternal damnation was threatened for the operation of abortion, and Cæsarean section was advocated to replace this accursed proceeding. In the middle of the thirteenth century Bishop Paulus of Meirada in Spain performed Cæsarean section upon a living woman. While the excellent practice taught by Hippocrates and by Soranus was slumbering in convent-walls, a new era was approaching; the foundation for true progress was being laid in the possibilities offered for anatomical study, and in the midst of the deepest darkness the light of modern science was beginning to dawn.

## II. Scientific Obstetrics, 1550 to 1888.

The sixteenth century, a period full of historic importance, pregnant with wonderful developments, marks the beginning of a new era in obstetric art, and its development from this time forth is that of an art previously unknown: new discoveries are made, and practices taught centuries ago are rediscovered and perfected by the light of recently-acquired knowledge. The growth of obstetrics is like that of a new art, more healthful for the casting off of pre-existing prejudices. Strange as this may appear, it is a course equally well marked in the rise and progress of gynecology, the speculum, an instrument figured upon Egyptian monuments, described by Roman authors, remaining unknown until rediscovered less than a century ago.

Notwithstanding the importance of skilful aid for childbearing woman, obstetric art developed but slowly, and did not keep pace with other branches of medicine, as it still remained in the hands of empirically-educated midwives, and the surgical features alone received attention, the obstetric work of the medical man being limited to embryotomy; the practice of midwifery was naturally looked upon as a part of the surgeon's art.

The progress of this new-found art and science of obstetrics reveals two well-marked periods: the first is the *period of development*, from the rediscovery of podalic version in 1550 to the beginning of the nineteenth century; the second is the *period of perfection*, continuing to the present time. The period of development is still characterized by the prejudices of previous ages; it is instrumental: abnormal cases only are worthy of recognition, and their management is a part of the surgeon's art. The various steps of progress are marked by the discovery of new instruments or operations: the great surgeons are the obstetric teachers. Not until the present century with the period of progress do we see the complete emancipation from surgery accomplished, and the development and perfection of life-saving methods is the characteristic which now marks progressive steps—the development of non-operative procedures, the study of the physiology of labor, and the prevention of pathological processes.

### A. PERIOD OF DEVELOPMENT—SURGICAL PERIOD—1550 TO 1800.

The most striking feature which distinguishes the scientific from the empirical practice is in the effort toward the preservation of fœtal life, and the three epochs of this first period, that of the development of scientific obstetrics, are marked by the discovery of instruments and methods by which this may be accomplished.

The *first period* is that of podalic version and beginning anatomical study, 1550 to 1647; *the second* commences with the discovery of the forceps, and is characterized by the inauguration of obstetric teaching and obstetric publications; *the third*, which includes the second half of the eighteenth century, from 1745 to 1800, is marked by the perfection of the obstetric forceps, the addition of the pelvic curve, the development of physiological knowledge of the sexual organs, and the induction of premature labor for the purpose of supplanting embryotomy.

*First Period: Podalic Version—Pelvic Anatomy.*—The spirit of progress which was aroused by the scientific discoveries of the sixteenth century exerted but a tardy influence upon the obstetric art, which continued in the hands of ignorant women. One of the first obstetric publications, that of Eucharius Röslin of Frankfurt-on-the-Main, well characterizes the esteem in which this practice was held: it is a book for midwives, an inferior compilation, entitled *The Rose-Garden of the Pregnant Woman's Nurse*, Worms, 1513, and contains but one indication of progress, a reference to podalic version, showing that the importance of this operation was beginning to be appreciated, which in the year 1550 was for the first time fully described by the great French surgeon Ambroise Paré. Like many other discoveries, it had long been foreshadowed, but to Paré is due the credit of making known to the profession as feasible and successful this most important of all obstetric operations, which was for the child what the discovery of the infectious nature of puerperal fever by Semmelweiss was for the mother, and which laid the foundation for the emancipation of obstetrics from surgery, and thus proved the first step in its development as an independent art. First taught by Paré, the operation was more fully described by his follower Guillemeau. Of almost equal importance were the anatomical labors of Andreas Vesalius, who, in his work *De Corpore Humano*, Basil, 1545–55, gave the first correct description of the normal pelvis. In 1581 the first independent treatise upon the Cæsarean section was published by François Rousset in Paris, although individual cases had previously been reported, and one positively recorded in Italy in the year 1540 by Christopher Bain. Rousset describes ten cases performed by barbers, the patients in several instances being confined repeatedly thereafter, and in one instance the operation was performed in six successive pregnancies upon the same patient.

The opposition of Paré to this operation checked its further development in France, and it disappears for a time from obstetric history, notwithstanding the labors of Aranzi of Bologna, who fairly defines the indications for Cæsarean section in a paper, *De Formato Fœtu*, in which he also touches upon the deformities of the pelvis. A school for midwives was established in the Hôtel Dieu in Paris, and of this the famous Louise Bourgeois was one of the first graduates.

The first impulse to the development of the obstetric art was given in France, and this country continued for a long time the centre of its progress. The position which midwifery took among the medical sciences is well characterized by the fact that its greatest teacher, Paré, was a surgeon: the most important operation, Cæsarean section, was performed by barbers; and one of the ablest practitioners, Louise Bourgeois, was a woman, a midwife of high position, *sage femme* to Marie de Medici, the book in which she publishes her observations being one of the most popular textbooks. Upon the teachings of Paré was based the progress of a hundred years until a new era was inaugurated by the obstetric forceps.

*Second Period: The Obstetric Forceps.*—From the discovery of the instrument, 1647, to its perfection by the addition of the pelvic curve by Levret, 1745.

*The Period of the Straight Forceps.*—Whilst the previous century, the most important in the history of civilization, had been marked by the foundation of universities, the discovery of printing, the development of art, we enter now into the philosophic epoch of Bacon and the labors of Sydenham and Harvey, the development of anatomy, and the beginning of physiological study, which exercised a powerful influence upon the course of obstetric art. Whilst tractors of various kinds have been used for the extraction of the fœtus, loops and hooks, such as are still applied to the head by the Chinese, simple catching instruments for the pulling out of the dead fœtus, were the true predecessors of the obstetric forceps, which we must accredit to the Chamberlains—or Chambellans, as they were called before their emigration to England. Dr. William Chamberlain left France in 1569 with other Huguenots during the period of persecution, and with his sons entered upon the practice of his art in England. An energetic, enterprising family, they made good use of the precious secret which they had somehow obtained, growing in wealth and standing: they even entered the political arena, devising wonderful money-making schemes. It was the grandson of the exile, Peter Chamberlain, Jr., who, though a member of the Barber Surgeons' Company, is known by his constant contests with physicians in behalf of the midwives; and his son, Hugh Chamberlain, Sr., born in London in 1630, the best known of the family, after numerous political intrigues was obliged to flee to Holland, where he sold his secret to Roonhuyzen, who behaved so shamefully that it was finally bought from him by the Surgeons' Guild of Amsterdam, and thus became public property. These instruments were flat, broad metallic blades of unequal width covered with leather and without a pelvic curve.

Whilst the obstetric forceps was unquestionably first and most frequently applied by members of the Chambellan—then Chambellaine, Chamberlaine, and finally Chamberlain—family, little credit is given them by the medical profession of the present day on account of the disgraceful way in which they sought to benefit by the secret; and this secret they undoubtedly received from another. The credit is generally given to a Belgian, Jean Palfyn of Courtrai (1650–1730), who himself discovered an instrument which he presented to the Paris Academy in 1721. This consisted of two non-fenestrated blades, nine inches long by twenty-two lines in breadth, of steel, with wooden handles held together by a cloth. The first description was published in Germany by Heister in 1724, who received his instrument from Palfyn, and in England soon after in 1733 by Chapman and Gifford. Improvements were made in 1735 by Dusé, who crossed the handles, by Gregoire of Paris, who fenestrated the blades and added a pin to the lock, and by Chapman, who constructed the first real lock.

The discovery of the obstetric forceps gave a powerful impulse to the development of the art; improved facilities were offered for the instruction of both midwives and physicians by the founding of obstetric schools; the first chair for the obstetric instruction of medical students was established at the Hôtel Dieu in Paris, 1720, and occupied by Gregoire the elder, and in 1743 the first school for midwives, under the same master; the first complete work on obstetrics, based upon scientific principles, was published by François Mauriceau (1637 to 1709) in 1668; and it is well worthy of note that Mauriceau was the first to confine his patients in bed—a bold innovation, as the obstetric chair was looked upon as the only proper place for a confinement *lege artis;* but, like other of the customary methods, the obstetric chair did not yield readily, and retained supremacy until the beginning of the nineteenth century. The deformities of the pelvis were studied by De la Motte in Holland; Roonhuyzen and Deventer assisted in the development of the newly-acquired art: the former had purchased the forceps from the Chamberlains and devised the lever or vectis, about as it has been used until the present day; the latter, originally a goldbeater with mechanical talent, was one of the first to study the deformities of the pelvis. In Germany the most advanced teachings are represented by the publications of Justina Sigmundin, midwife to the court of Brandenburg.

*Third Period: Development of the Forceps*, and their perfection by the addition of the pelvic curve; limitation of embryotomy by the inauguration of premature labor, 1745 to 1800.

The latter half of the eighteenth century is the culmination of the surgical period, and obstetric art is greatly advanced by the distinguished surgeons of that time, such as Hunter, Levret, Smellie, Roederer, Denman, Stein, Saxtorph, Solayres, and his pupil Baudelocque; but, prominent as practitioners and authors as well, we still find women, the famous midwives Mesdames Lachapelle (1769 to 1821) and Boivin (1773 to 1841).

The results of anatomical and physiological study are beginning to appear, and obstetric practice is modified by the fuller knowledge of the pelvic canal (Smellie) and of the functions of the uterine muscle (Hunter); a most thorough description of the normal and abnormal pelvis is given by André Levret (1703 to 1780), whose most important treatises are upon the pelvic axis and placenta prævia; a result of his anatomical studies was the improvement of the obstetric forceps by the addition of the pelvic curve, which gives a far wider range to its utility, admitting of its application in the higher straits of the pelvis. He also improved the lock, and the instrument as devised by him is the one which still retains supremacy in France, yielding only in extreme cases to the Tarnier axis-traction forceps.

Smellie, in his treatise on the theory and practice of midwifery, 1754, gives the first thoroughly exact obstetric description of the pelvis, with dimensions and measurements of the various diameters, two hundred years after the crude description of Vesalius afforded the first basis for obstetric progress. The influence of physiological study appears in the classical work of William Hunter, whose anatomy of the gravid uterus (1774) was so long unsurpassed. His efforts were directed in opposition to the operative tendencies of the times, which resulted from the perfection of obstetric instruments, and, contrary to most of his contemporaries, he sought to limit instrumental interference, even the application of the forceps, to the most necessary cases; and Thomas Denman continued in the course advocated by his able master, as Baudelocque in France established the physiological teaching of Solayres at a later period.

The beneficent influence of the physiological tendency is also visible in the efforts to replace embryotomy and the dangerous Cæsarean section: the inauguration of premature labor was recommended for the former, symphyseotomy for the latter. The elder Pineau in 1575 theoretically recommended symphyseotomy, but in 1665 it was performed for the first time after sudden death in pregnancy. In 1768 it was again proposed to the Paris Academy by Signault, without receiving attention; finally, in 1777, an operation performed for rachitic deformity of the pelvis called attention to the merits of the procedure, but, though resorted to quite frequently with varying success, the opposition of Baudelocque caused it to disappear completely.

The operation for the induction of premature labor, in thorough accord with the spirit of the times, received the sanction of the best practitioners: it was first advocated at a meeting of London obstetricians in 1756, to whom the procedure had been suggested by the knowledge of the fact that women with a narrow pelvis, who were by chance prematurely confined, bore living children. Macaulay was the first to operate successfully with the definite purpose in view of securing a living child in a case in which embryotomy had been previously necessitated in delivery at term.

François Louis Jos. Solayres de Renhac, in his dissertation published in Paris in 1771, laid the foundation for the coming era in his efforts to found obstetric practice upon the physiology of parturition, the physical conditions of the pelvis, and the mechanical activity of the uterine muscle. Upon the teaching of this French physician the work of Baudelocque was founded, and from this came the modern physiological school of obstetrics.

The earliest German work of this period is that of Heister, which appears merely as a part of his general surgery: to Fried of Strasburg (1689 to 1764) we must trace the beginning of obstetric teaching in that country. In 1751 a school of midwives was established at the Charité in Berlin, and placed in charge of Meckel. In Italy obstetric chairs were established at the University of Florence, 1761; in Milan, 1767; in Naples, 1778. In Dublin, in Edinburgh, and in London obstetric schools had existed since the middle of the eighteenth century.

France still continued as the centre of obstetric development, with ample opportunities for the instruction of both male and female students: the long forceps of Levret were commonly used. In England the shorter instrument of Smellie was almost universal. In Germany the use of the forceps had not yet become so common, and the practice of obstetrics was still more universally in the hands of midwives; yet schools even for their instruction had been but recently established: the forceps used were a modification of the French instrument, and somewhat smaller.

### B. PERIOD OF PERFECTION—PHYSIOLOGICAL PERIOD—1801 TO 1888.

The complete emancipation of obstetrics from surgery is at length achieved, and the instrumental tendency naturally resulting from surgical supremacy is yielding to the more rational physiological practice.

*The first epoch*, from 1801 to 1847, is devoted to the development of the physiological study of obstetrics.

*The second*, from 1847 to 1870, is marked by the medical progress of the art, the discovery of anæsthesia and of the infectious nature of puerperal fever; finally, in the

*Third and last period*, from 1871 to 1888, we find the culmination of all previous efforts by the aid of antiseptic practice.

1st. *The Physiological Period, 1801–47.*—Though Péan, Hunter, and others in the eighteenth century had already pointed out the importance of observing Nature's laws in the act of parturition, and had urged that the resort to artificial means be limited to such cases only in which Nature had failed, the possibilities of the recently improved obstetric forceps and the teachings of such masters as Levret and Smellie had carried obstetric practice far on in the course in which it had so long continued as a branch of the surgical art. Then came the sterling publication of Solayres (1771), with the effort to base obstetric practice upon anatomical and physiological laws; but, notwithstanding the continued efforts of Baudelocque, the instrumental, the interfering, obstetrics of Levret and Smellie did not yield to the modern physiological view until after the great changes wrought by the French Revolution, which shook Europe in its foundation; and at that time, with the establishment of the Maternité in Paris in 1798, the modern French school of obstetrics begins.

It is in this period, from the close of the last to the middle of the present century, that the foundation was laid for the practice of the obstetric art as it prevails to-day in its highest development. The obstetric forceps had been generally introduced, and the types then adopted in the various countries persist to the present day, notwithstanding the numerous modifications which have since appeared. Throughout France the forceps of Levret was used—a long steel instrument—and its supremacy has continued to the present day, even serving as a model for the very latest Tarnier forceps, which presents merely the addition of the axis-traction principle. The forceps of Naegele, Bush, and D'Outrepont, also long instruments with a somewhat different lock, prevail in Germany, and have been but little changed, as in England the adherence to the original model of Smellie is evidenced by the survival of the short forceps with a slight pelvic curve, which has of late slowly given way, in part, to Simpson's longer instrument, which is a slight modification of the Vienna forceps. In America preference is given to the native instruments of Hodge and Eliot.

Schools for midwives have been established, and opportunities for the study of obstetrics are afforded to medical students in all the more important universities. The emancipation of obstetrics from surgery is characterized by the labors and writings of independent teachers of obstetrics and by the attempts to render difficult labors less bloody and less dangerous.

During the period of the French Revolution the physiological tendency of obstetric art reached its climax in the École Anti-cæsarienne of Sacombe, a Parisian fanatic, who battled against the Cæsarean operation with all the weapons of the charlatan. He fortunately made no appreciable impression, yet may have exercised some influence upon the restraint which was put upon its execution; the formulating of more careful indications and an improvement in the method of operating were the results of the scientific progress of the period.

The induction of premature labor, which had been first advocated by

English physicians in 1756, was actually resorted to by Denman in Dublin, who records some twenty operations, and by Wenzel in Germany in 1804, who in that country performed the first operation, though it had been suggested by Mai in 1799. Little progress was made by reason of the earnest opposition of Baudelocque, probably under the influence of the Catholic Church in France; and by reason of the continued supremacy of the French school the fate of this proceeding for a time was sealed. Not until practised by Stoltz in Strasburg in 1831 was it again taken up in France, and by the advocacy of Dubois it was finally established, although practised at a much earlier day in dangerous hemorrhage from traumatism or placenta prævia.

Artificial abortion in earlier months now likewise received the attention of scientific obstetricians: this operation, practised both for criminal and economical purposes at all times and in all countries, brought about by primitive peoples by the introduction of dilating vegetable stems into the os uteri, taught by the Greeks as a resort in cases of narrow pelvis, disappeared with Christian civilization, at least as an acknowledged operation, until recommended in England by Cooper in 1717, again by Scheel in Copenhagen in 1799 for the purpose of reducing the mortality of the Cæsarean section; it appears in Germany in 1802 (Mende) and in France in 1835, when it received the sanction of Dubois and Cazeaux. Other attempts were made to replace the Cæsarean section by methods less dangerous: symphyseotomy was proposed by Signault in 1768, and the removal of the entire uterus by Cavallini of Florence in the same year; Michaelis of Marburg made this same suggestion in 1809, as did Blundell of London in 1828; gastro-elytrotomy was advocated by Jörg in 1807, and attempted by Ritgen in 1821; Physick of Philadelphia indicated the same course.

The frequency of pelvic deformities upon the northern coast of Germany led to the more general resort to podalic version, and as early as 1807 we find the combined and external version advocated by Wigand. In part, the preference of the Germans for version was due to the more tardy introduction of the forceps, the real home of which is in France and England; and this preference of the Germans for version as compared with the use of the forceps continues to the present day. The cephalotribe, devised by Baudelocque, was brought to the notice of the French Academy in 1829; the invention of the cranioclast by Sir James Y. Simpson soon followed; and, notwithstanding the present international tendencies of science, the influence of national prejudice is well marked in the still-continuing prevalence of the cephalotribe in France and cranioclast in England, whilst in Germany the former was the more commonly used until partially replaced by the instrument of Braun of Vienna. In America, where the necessity for the use of destructive

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instruments is fortunately but slight, the cranioclast of Hodge indicates the influence of English obstetrics.

In this period appeared the last of the great midwives, Marie Lachapelle (1769 to 1821) and Marie Boivin (1773 to 1841), like the obstetric chair, relics of a previous epoch which was fast passing away with the perfection of anatomical and physiological knowledge and the development of a thoroughly scientific obstetric practice.

In England an excellent and practical school had been established; the low-forceps operation was popularized; and the judicious teaching of Denman resulted in greater precaution against the carrying of infection and the replacing of the Cæsarean section by the inauguration of premature labor. German obstetricians succeeded in overcoming many of the difficulties of labor caused by pelvic deformities, and from Germany came the first thorough embryological researches, the classical work of Meckel, which appeared in 1812, and the premature labors of Casper Friederich Wolff almost half a century before. The supremacy attained by the French school in medical and obstetric science, due in part to the advantages afforded by the excellent schools and the great hospitals of Paris and the able men there concentrated, was perpetuated by the work of Cruveilhier in pathological anatomy and the anatomical and physiological studies of Bichat.

In the young republic of the Western hemisphere the struggle for existence and material comfort left but little leisure for scientific study, yet such men as Dewees, Meigs, and Hodge, notwithstanding the limited facilities afforded by private practice, have secured an honored place for American obstetrics in the history of medicine.

The discovery of the oxytocic property of ergot is due to John Stearns, president of the Academy of Medicine, who published his observations in the *New York Medical Repository* in 1807.

William P. Dewees (1768 to 1841) first called attention to the dangers of cardiac thrombosis in childbed, though, like other premature discoveries, it was neglected and forgotten until again taught by Rudolph Virchow of Berlin in a period of more advanced pathological knowledge.

Hugh L. Hodge (1788 to 1873) devised the forceps which has been most generally adopted in this country; his craniotomy scissors, compressor cranii, and placental forceps have likewise found general favor.

The English obstetricians of this time are Denman, Ramsbotham of London, his successor Hamilton of Edinburgh, and later Sir James Y. Simpson (1841 to 1870).

The French are, Baudelocque, later Cazeaux and Dubois.

The Germans, Osiander, who suggested the addition of a tractor to the forceps; Wigand of Hamburg (1769 to 1817); Naegele of Heidelberg (1778 to 1851); Bush of Berlin (1788 to 1858); D'Outrepont of Wurtzburg; Siebold, the author of the history of obstetrics; and Michaelis, famed for his studies of the contracted pelvis.

2d. *From the Discovery of Anæsthesia to the Antiseptic Period, 1847 to 1870.*—Anatomical and physical science has been thoroughly developed, and pathological anatomy, together with a more perfect knowledge of embryology, now comes to the aid of the obstetric art. The knowledge of the mechanism of labor has been perfected, the true force of expulsion has been correctly ascribed to the uterine muscle, and abdominal pressure relegated to its appropriate subordinate position. Distinct indications are being established for the various obstetric operations; craniotomy and embryotomy are being gradually limited to their proper sphere: whilst version takes the place of embryotomy in malposition, greater skill in the use of the forceps has reduced the necessity for perforation to the more contracted forms of the pelvis in cephalic presentations.

During this period, from 1847 to 1870, the surgical procedures previously discovered are developed and perfected, and the thorough individualization of obstetric art and its amalgamation with the medical sciences are characterized by a progress which keeps pace with the scientific discoveries of the time. Obstetric operations, favored by the use of anæsthetics, attain the highest possible perfection before the antiseptic period. Little that is actually new appears at this time: the leading features of these two decades are the discovery of anæsthesia by the American dentists Jackson and Morton, and the introduction of chloroform into obstetric practice by Simpson in 1847; the discovery of the infectious nature of puerperal fever by Semmelweiss in 1847, of combined version by Wright of Cincinnati in 1854; and the utilization of external manipulations for placental expression by Crede in 1860.

Dr. Jackson of Boston first used sulphuric ether (1841), which was also tried by Horace Wells, a dentist of Hartford, Connecticut, in 1844, but abandoned for laughing gas; and to Morton, a student of Jackson's, who first used ether in large operations at the instigation of his tutor, is usually given the credit of its introduction. To Sir James Y. Simpson is due the credit of introducing the use of anæsthesia in labor, and in Nov., 1847, he reported to the Edinburgh Medical Society the results of his observation in 50 cases of anæsthesia from the chloroform recently discovered by Bell and Flourens; a most exhaustive work upon the use of ether in childbed was published by Dr. Channing of this country in 1848, and this work of 400 pages, containing these first experiments, has almost exhausted the subject and is still worthy of perusal.

Whilst the new agent was readily received by foreign obstetricians and used to mitigate the suffering of the patient in the more dangerous obstetric operations, it was only in England and America, and more particularly in this country, that it was generally adopted by the profession at large for the relief of pain in ordinary labor. In no other country is the use of ergot and of anæsthesia in childbirth so common as in America, and, whilst with advancing knowledge the application of chloroform is growing more frequent, though its administration is more judicious and more carefully guarded, the administration of ergot is now much less common. The use of this powerful and dangerous drug, which attained a most unpardonable expanse, is being rapidly limited to its proper sphere: developed to a dangerous extent in this period, it became so common that it was given by midwives and nurses, and but few labors were concluded in which ergot was not given by the general practitioner throughout the country; it was relied upon in retarded expulsion of the fœtus and in cases in which the forceps should have been applied.

The most important discovery of the century, however, and the one to which the preservation of more lives is due than to any one surgical procedure, is that of the infectious nature of childbed fever by Semmelweiss in 1847. So highly are the labors of Semmelweiss, who pointed out the dread fiend which gave such terrors to the physiological process of childbirth, regarded, that Schroeder in his work on obstetrics says, and truly, "I believe that wherever the benefactors of mankind are mentioned the name of Semmelweiss should rank pre-eminent;" and, although he at first claimed that puerperal fever was due to infection by cadaveric poison, he gradually enlarged his views, so that our present theories may be based upon his teachings. Notwithstanding the fact that epidemics had been observed at various times, he was the first who positively pointed out the infectious nature of the disease and the most important of the precautions to be observed for the sake of preventing its spread. As assistant physician at one of the Vienna maternities, in charge of two clinics, one devoted to the instruction of midwives, the other to that of medical students, he was struck with the prevalence of puerperal fever in the latter and its comparative absence in the former, and attributed it to the fact that the medical students were engaged in dissections and post-mortem examinations, and thence conveyed the poison, from which the disease developed, to women in labor or recently delivered; and at that early day he took the very precautions to which we now resort: he required the students to use thorough disinfection before entering the obstetric wards. At once the mortality of puerperal women, which hitherto had been 15 per cent., was reduced, and became even less than in those devoted to the instruction of midwives (Parvin). His investigations show that from August, 1784, to December, 1822, during which period the physicians connected with the Vienna clinic performed no autopsies, 71,395 women were confined, with 897 deaths, a mortality of 1.23 per cent. From the 1st of January, 1823, to the 1st of January, 1833, post-mortems were made, and the mortality increased to 5.30 per cent.—28,429 deliveries and 1509 deaths. In the period immediately preceding the advent of Semmelweiss it was as high as 9.92 per cent. After the precautions introduced by Semmelweiss the mortality suddenly dropped to 1.27 per cent., whilst with our present antiseptic methods the mortality in some of the best lying-in hospitals is less than one-half of 1 per cent.

Deadly fevers in childbed connected with cessation of the lochial flow had been observed by Hippocrates and by Galen: epidemics are even recorded at that early day, and again in the Middle Ages. A terrible mortality followed an epidemic of puerperal fever at the Hôtel Dieu in 1664, this epidemic and the increased mortality since that time being attributed to the proximity of surgical cases. The Dublin Maternity was desolated in 1672, as recorded by Thomas Bartholyn, but the epidemic of 1773 was the first one in which efforts were made to investigate the causes. Abundant opportunity was offered for study and observation as the fever swept over the European continent, and more than decimated the lying-in hospitals, the terrible ravages of the disease culminating in the miasmatic plains of Lombardy during the year 1786 in an epidemic from which not a single puerpera recovered. In 1829, 252 deaths are recorded in the Maternité of Paris in 2788 labor cases; in 1831 there were 254 deaths in 2907 cases. Denman proved that puerperal fever could be carried, and that contact with erysipelas, offensive ulcers, and sloughing wounds would produce this deadly disease in the puerperal woman; and his warning was so generally accepted that it was quite customary among English physicians not to go to labor cases after visiting such patients. Again, in 1845, Oliver Wendell Holmes directed the attention of the profession to the true nature of this malady and to the necessary precautions, but, it seems, to no purpose.

Notwithstanding the terrible ravages of the disease in the great maternities, and the correct observations of prominent obstetricians at all times, no further notice was taken of the fact; it was looked upon as a necessary accompaniment of large hospitals, until at last the teachings of Semmelweiss aroused the profession, and even then the full truth was not thoroughly appreciated. But a beginning was made and precautions were taken by more enlightened physicians by which numerous lives were saved, and these epidemics in the lying-in hospitals, though still dangerous, were robbed of their greatest terrors. Not until the introduction of antiseptic practice was this greatest enemy of lying-in women completely overcome.

In 1854, Dr. M. B. Wright of Cincinnati perfected the methods of version by the introduction of the combined method of bimanual podalic version, which he published in a paper on *Difficult Labors and* *their Treatment*, for which he received the gold medal of the American Medical Association. Yet, coming from the American wilds, it was ignored as had been the teachings of Oliver Wendell Holmes, and little heed was given this proceeding, which bears the name of a later discoverer, Braxton Hicks. Though taught by Wigand of Hamburg in 1807, it was completely overlooked, and not even the French translation of Wigand's work thirty years later directed attention to this important procedure. The history of combined version is like that of almost all the earlier methods before the present era of international science—discovered and again forgotten, only to be rediscovered and lost until brought forward at the right moment. So it was left for Braxton Hicks to introduce the combined external and internal version into general obstetric practice by his paper published in the *Lancet* in 1860 and read before the London Obstetric Society in 1863.

Strange as it may seem, this method—the scientific application of manipulations which we find in the earliest primitive epoch—was completely lost and rediscovered as something entirely new in the most advanced era. But so it was with the placental expression of Crede, which he gave to the profession in 1860, and which has borne his name ever since. The kneading of the abdomen with manual pressure on the fundus was a common practice in the primitive epoch; friction and pressure upon the fundus, either by the hands or by the tightening of a belt or a towel, or even by the hands of the patient herself, are the methods resorted to by primitive peoples at the present day, as they were thousands of years ago, and yet English obstetricians claim the discovery of manual expression for the Dublin school, while the Germans accord it to Crede. As a method it will continue to carry the name of Crede, the one who first fully described it as a scientific obstetric procedure.

Nothing seems more natural, yet the history of this practice is the same as that of other of the manipulations common in the earliest epochs, which have been lost or have yielded to a much less rational method in the darkness of beginning knowledge. For instance, the placental expression of the intuitive practice yielded to traction on the cord, which is the most common resort of midwives at the present day, and an incarcerated placenta, due to a tearing of the cord, is still not uncommon in the practice of midwives and even physicians. Strange as it may seem, in this advanced era of scientific medicine it is the progressive obstetrician only who appreciates and utilizes the intuitive practices of the earliest epoch.

Among the English obstetricians we may mention: Matthews Duncan, McClintock, Leishman, Churchill, Braxton Hicks, and Barnes; among the French, Depaul and Pajot; among the German, Scanzoni, Crede, Martin, Spiegelberg, and Braun; in America, G. S. Bedford, William H. Byford, Penrose, Isaac E. Taylor, Fordyce Barker, Albert H. Smith, and Ellwood Wilson.

## III. THE ANTISEPTIC PERIOD, 1870 TO 1888.

This period will be for ever characterized in the history of midwifery by the introduction of antiseptic practice into the obstetric art, and by the almost complete disappearance of puerperal fever from the great lying-in hospitals; by the introduction of the Tarnier forceps, which has resulted in the perfection of the high-forceps operation and more general application of the axis-traction principle; and, finally, by the almost ideal perfection attained by the Cæsarean section, which, with a mortality of but 17 per cent., is established as one of the acknowledged obstetric operations, even promising to replace the artificial induction of abortion and premature labor.

The *first decade* of this period, from 1870 to 1880, is that of active antiseptic midwifery, of intra-uterine injections, the destruction of the poison by germicides, mainly carbolic acid; whilst the

*Second*, the present decade, from 1880 to 1888, may be called the aseptic period, the prophylactic period, the period of prevention. The nature of the dangerous poison has been revealed by Pasteur, by Tarnier and Koch, and we no longer battle with the established disease, but seek to prevent its development, to guard against the threatening danger. The first decade is that of antisepsis; the second, that of asepsis or prophylaxis. The most important innovations during this period, in their chronological order, are as follows:

The revival of symphyseotomy in Italy by Morisani and Novi of Naples: in cases with a conjugata vera less than 6.7 cm., or 2⅝ inches (Parvin-Harris), from 1866 to 1881, 43 women and 42 children were saved by 53 operations, the pubic joint being divided by a small, sickle-shaped, probe-pointed knife (the falcetta of Galbiati).

1870. First application of the principle of antisepsis by Prof. Stadtfeldt in the Copenhagen maternity by the use of carbolized 2 per cent. vaginal injections; thorough disinfection of the medical personnel; washing of hands in 2½ per cent. solution; 10 per cent. carbolized oil as a lubricant; injections every two hours during labor; during the puerperium bathing of the genitalia two or three times a day with carbolized water; intra-uterine injections of 3, 4, and 5 per cent. solutions being reserved for operative cases and the retention of membranous débris.

Spiegelberg urges the importance of the early performance of craniotomy, presenting his own experience, 3 deaths in 33 cases from 1870 to 1877, contrasted with 13 cases and 7 deaths as the result of a more expectant plan and tardy operation, as practised from 1865 to 1870.

1871. Among the various methods advocated for the preservation of the perineum to take the place of the universal and frequently injurious and antiquated practice known as the support of the perineum, the hand pressing the perineum and the head against the symphysis, is that of Goodell, the holding back of the head by placing the thumb against the occiput, at the same time drawing forward the perineum by one or two fingers hooked in the rectum.

1874. First correct and complete macroscopic and microscopic description of the uterine decidua and the development of fœtal and maternal tissues toward the formation of the placenta by Kundrat of Vienna and Engelmann of St. Louis: the placenta is formed by the growth of the decidua serotina toward and into the villi of the chorion. The development of the decidua, the method of its expulsion and new growth, are described as now generally accepted with but few variations, which were presented by Leopold of Leipzig two years later.

1875. Prophylactic, antiseptic measures first introduced in lying-in wards by Bischoff in Switzerland.

1876. Gastro-elytrotomy proposed by Gaillard Thomas of New York as a more safe and conservative method to replace Cæsarean section, which had hitherto been so unsuccessful. The method was published after a successful operation by Dr. Skene of Brooklyn. The first operation performed by Thomas in 1870 resulted fatally to mother and child.

1876. Prof. Porro of Pavia first performed the operation known by his name, though he had already suggested in 1874 the removal of the uterus and its appendages, after extraction of the child, as a substitute for Cæsarean section in cases of contracted pelvis.

1876. Intra-uterine injections of hot water, 122° to 129° Fahr., 50° to 54° C., recommended by Emmet in gynecological cases, first used upon a larger scale in lying-in hospitals as a hæmostatic for the purpose of controlling post-partum hemorrhage.

1876. The use of gynecological instruments advocated for the purpose of facilitating obstetric operations by Dr. Skene of Brooklyn.

1876. Viburnum prunifolium, a popular remedy in the Southern States, suggested as a uterine sedative for the purpose of preventing threatened abortion by Dr. Jenks of Detroit. Its antiabortive qualities had been previously noted by Dr. Phare of Mississippi, and were known to Southern physicians.

1876. Active antiseptic practice at its height; prophylactic intra-uterine injections frequently made. Prof. Winckel of Dresden calls attention to the danger of this practice.

1877. First model of the axis-traction forceps presented to the Paris Academy by Prof. Tarnier.

1878. Prof. Müller of Bern modifies the Porro operation by prolonging the abdominal incision from the symphysis to two fingers' breadth below the umbilicus, by raising the uterus out of the abdomen, and by contracting the cervix by the elastic ligature before making the uterine incision—a practice which has been generally adopted under the name of the Porro-Müller operation.

1879. Dangers of intra-uterine injection shown by Veit of Bonn by 10 serious accidents in 400 injections.

1880. Hoffmeier and Runge of Berlin clearly demonstrated the uselessness and danger of prophylactic post-partum injections, as advocated by Schulein and Richter.

The efforts of Schroeder and Gusserow, of Winckel and Breisky, in behalf of the new movement toward cleanliness and asepsis served greatly to check the progress of officious over-active antisepsis.

1880. Crede applies the antiseptic method for the prevention of ophthalmia neonatorum by the instillation into the eye of a single drop of nitrate-of-silver solution, 1 : 50. In 1879 he had employed vaginal douches of 2 per cent. carbolized or salicylated solution in all women suffering from vaginitis who presented themselves at the Leipzig Maternity; though the cases of ophthalmia neonatorum diminished, they did not cease. He then used an instillation of borax, 1 : 60. The desired result was still not achieved, and injections of nitrate of silver, 1 : 40, caused too great an irritation; but, notwithstanding the class of cases received at a lying-in hospital, ophthalmia neonatorum is now completely eradicated by the introduction of the practice of Crede in all larger maternities. A single drop of a solution of nitrate of silver, 1 : 50, is instilled into the eye immediately after birth, and for twenty-four hours thereafter a compress soaked in a solution of salicylic acid, 2 per cent., is applied to the eyelids. The frequency of the disease, previously from 7 to 13 per cent., is now almost zero.

1880. Dohrn introduces a dry antiseptic dressing over the umbilical wound to prevent the transport of germs and to hasten desiccation. A dressing of carbolized wadding is applied to the umbilical region after a thorough washing with a 2½ per cent. carbolized solution. We have a repetition of one of the most primitive methods, antisepsis and desiccation by fire, as recorded in the practice of the intuitive epoch.

Great improvements are made in the methods of treating the asphyxia of the newborn child: the dangerous and very common practice of blowing air into its lungs, which succeeded in forcing the mucus or liquor amnii, most usually the cause of the asphyxia, well into the bronchi, has given way to the cleansing of the bronchial tubes by the removal of the obstructing fluids by suction; and now the perfected methods of inducing artificial respiration were applied for the resuscitation of the asphyxiated child by Behm, Schultze, and Schuller, bringing into play especially the diaphragm and the thoracic muscles by movements of the arms and legs.

In European clinics the use of ergot during labor has completely disappeared, and the giving of the drug is restricted to the uterus after expulsion of its contents. In America this practice is now slowly gaining ground.

1881. The bichloride of mercury was introduced by Tarnier, and its use, as recommended by him, in solutions of 1 : 2000 and 1 : 4000, was rapidly adopted in all countries.

1882. Garrigues successfully employs the faradic current for the destruction of the fœtus in extra-uterine gestation, one electrode being placed in contact with the tumor in the vagina, the other upon the abdomen over the uterine fundus, the current being gradually increased to such intensity as could be borne by the patient without suffering.

The antiseptic pad for the reception of the lochial discharge in place of the old-time napkin recommended by Richardson of Boston and Garrigues of Brooklyn.

1885. Bayer of Strasburg recommended galvanism as an agent for the purpose of exciting the induction of premature labor, but as the method seemed to possess no marked advantage over the more simple practices in general use, it received but little attention.

1886. The use of the faradic current in labor is recommended by Engelmann, in the first stage, in weakness and irregularity of labor-pains, to relieve pain and regulate the contractions; later, to stimulate the traction of the uterine muscle; in post-partum hemorrhage, as a hæmostatic equal to the hot douche or the perchloride of iron; and during the puerperium, for the purpose of overcoming subinvolution and the paralysis of urethra and bladder so annoying in the first days of childbed after difficult labor.

1886. The correctness of the theory of maternal impressions demonstrated by Fordyce Barker of New York in his paper before the American Gynecological Society. The possibility of this occurrence, so long one of the myths of obstetric science, has at last been proven as a positive fact.

1887. An international obstetric nomenclature, as suggested by Prof. Simpson of Edinburgh as chairman of the committee, was adopted by the Tenth International Medical Congress in its meeting at Washington.

1887. Hypnotism is used in Paris and Vienna in isolated cases to mitigate the pains of labor.

The most striking feature of this period is undoubtedly the introduction of antiseptic practice, the development of the high-forceps operation as a sequence of the axis-traction instrument of Tarnier, and the wonderful results of the Cæsarean section.

Notwithstanding that Semmelweiss in 1847 had so clearly indicated the true nature of the dangers which threaten puerperal women, and had practically demonstrated the possibility of prevention, the mortality in the wards of the great lying-in hospitals continued as great as ever before. Puerperal fever was looked upon as a necessary result of large institutions, and at that time safety was supposed to consist in confinement at the home of the patient. It was Lister who utilized the scientific researches of Pasteur and made the practical application from which sprang the rapid growth of antiseptic surgery. But the labors of Tarnier, who sought to benefit obstetric science by the new discovery, passed unheeded, and not until Stadtfeldt of Copenhagen practically applied the method upon a larger scale did antiseptic practice enter into the science of obstetrics. Its advantages once demonstrated, German obstetricians were quick to follow, and proved its most enthusiastic advocates. Carbolic acid was the antiseptic most generally employed and constantly applied—vaginal injections before labor, in many of the lying-in institutions the spray during labor, and prophylactic vaginal and intra-uterine injections after its completion. This abuse of antiseptics was followed by evil results, partially the effect of the remedy itself, carbolic acid, partially a mechanical injury: the chill which was often observed after the intra-uterine injection of carbolic acid must be ascribed to that agent, since it does not follow if corrosive sublimate is substituted.

The enthusiasm for the new antiseptic method led to an abuse which was followed by serious results. Veit of Bonn in 1879 recorded 10 deaths in 400 injections, but it was especially Runge and Hoffmeier of Berlin who called attention to the dangers of this abuse. Guided by the progress of the antiseptic methods in surgery, Winckel, Breisky, Schroeder, and Gusserow inaugurated a new departure, the result of which is the present aseptic or prophylactic method, based upon the belief that infection is guarded against most safely by preventing the introduction of poisonous matter; hence the war should be directed against the possible carriers of infection—the obstetrician himself, his instruments, and attendants. The dangers of carbolic acid, together with the annoyances accompanying its use, the odor, and the greater quantity necessary, caused the ready reception of the corrosive sublimate recommended by Tarnier in 1881; and his is the method now generally practised in all the larger lying-in institutions—the most thorough prophylaxis, absolute cleanliness of room and bed; vaginal injections before labor and washing of the parts with a solution of 1 : 2000; perfect cleansing of the parts after labor with the same solution, and the reception of the lochial discharge in pads of an antiseptic material, oakum or cotton, which can be thrown away or burned as soon as saturated. Unless necessitated by unusual causes, the hand is not introduced, and Crede's method is resorted to for the removal of the placenta. The expectant plan, as now advocated by Crede, has come into general use, both as being in itself the most satisfactory and safe, and by causing the expulsion of a tardy placenta by external pressure, avoiding the necessity of introducing the hand.

The most important of all antiseptic precautions is the cleanliness and perfect asepsis of the attendants, and especially of their hands; in this centres the advanced asepsis of the present day both in obstetrics and in surgery: a thorough scrubbing of the hands with brush and soap, followed by a washing in the bichloride solution of 1 : 1000; all instruments used are placed in the same solution. For intrauterine injections a solution of 1 : 4000 is preferred, as the toxic effects of mercury frequently appeared in the earlier practice with a solution of 1 : 2000; but careful observation of the individual patient is necessary even if the weaker solution of 1 : 4000 is used, as idiosyncrasies are frequent. In the Charité, for instance, poisoning by corrosive sublimate was observed in 9 out of 35 cases in whom vaginal injections of eight liters daily were used of a solution of 1 : 4000. If lubricants are used, glycerin of vaseline with carbolic acid or corrosive sublimate is preferable, but for ordinary examinations it is best to insert the finger still moist with the antiseptic solution.

The recent tables of Bar show a mortality in the Maternité of Paris varying between 7 and 20 per cent. from 1860 to 1870, where now a mortality of but $1\frac{1}{10}$ per cent. is found. In the Prague maternity it is $\frac{36}{100}$ per cent., 11 cases in 3010 in 1879, fluctuating in the various lying-in institutions during the first decade of the antiseptic period from 1870 to 1880, between $\frac{1}{2}$ per cent. in the smaller ones in which antiseptics had been introduced, and 2 per cent. in the Paris Maternité, whilst with the present system of prophylactic antisepsis it has been excluded almost completely, so that we see but a few isolated cases.

Leopold records[1] in 1686 labors from May, 1885, to May, 1886, not a single death from infection; in 1403 labors from May, 1886, to May, 1887, not a single infection; and we must remember that this is in a lying-in hospital, where numerous cases of deformity of the pelvis occur and operations are frequent; although not so frequent as, for instance, in the clinic and polyclinic of Halle, where in 1553 labors we find a record of 694 forceps cases, 351 versions, 195 podalic extractions. 29 craniotomies, 5 embryotomies—82 per cent. of operative cases.

*The Cæsarean Section.*—Strange as it may seem, notwithstanding the wonderful progress of surgery, the Cæsarean section remained a dangerous, almost necessarily fatal, last resort until within the last ten years—equally fatal in the hands of the modern surgeon and of the Buddhist priest, as it had been in the Middle Ages, as it was among the negroes of Africa; hence it was but natural that other means should be looked for. Symphyseotomy, though practised with remarkable success in Italy by Morisani and Novi of Naples, saving 43 mothers and 42 children in 53 operations, was not received with favor by the profession: gastro-elytrotomy, earnestly recommended by Thomas in 1876, likewise found but few imitators. Proposed by Jörg in 1806, attempted by Ritgen with fatal result in 1820, suggested by Physick in 1822, again proposed by Baudelocque in 1823, and performed with fatal result by Thomas and Skene, it was not until after the first successful case by Skene of Brooklyn that Thomas ventured to propose this method in place of the old Cæsarean section; the results achieved were no better, and, moreover, the danger of wounding the ureters or bladder, and the long suppuration of the vagino-abdominal wound which followed, proved a serious obstacle to its success. The operation proposed and successfully performed by Porro in 1876 seemed to satisfy the profession, which had been long in search of a less dangerous substitute for the Cæsarean section, and it was generally accepted; improved by Müller of Bern in 1878, it received the sanction of the Vienna school, and for a time completely displaced the Cæsarean section. The indefatigable labors of Harris of Philadelphia in behalf of the classical operation had served to keep the Cæsarean section before the profession, and it was due to the efforts of Saenger of Leipzig, who looked upon this as a conservative method in comparison with that of Porro, that the old operation was again given a trial; and by the method suggested by Saenger, and first practised by Leopold, the results achieved were equal and superior to that of the Porro-Müller operation; 150 cases of the Porro operation presented a mortality of 54 per cent. to the 40 per cent. in 40 cases of Saenger's conservative operation. Later statistics show but a mortality of 25 per cent. in 58 cases, so that the question now arises whether craniotomy in case of a living child should not give place to this operation.

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[1] *Deutsche medicinische Wochenschrift*, 1887. vol. xiii. 25.

Crede, in his latest paper urging the conservative Cæsarean section in place of perforation, states that the latest statistics show a mortality of 8.4 per cent. in cases of perforation and 17.5 in Cæsarean section, and adds that in the latest cases operated on in Dresden and Leipzig by himself, Saenger, and Leopold, the maternal mortality in Cæsarean section has been reduced to 5 per cent.; yet such advances have been made in craniotomy that a successful operation is now possible in a conjugata vera of but 3½ cm., and judgment must be withheld until this operation has been perfected and tested with all antiseptic precautions.

The temporary success of the Porro operation was due to the fact of its introduction in the first period of successful antiseptic laparotomy.

But it has now taken its proper place: in those cases in which hemorrhage is especially to be feared, the old Cæsarean section is decidedly preferable, as bleeding is thus best controlled, whilst if sepsis threatens the Porro operation offers the most favorable prognosis. But under certain circumstances, disease of the cervix, carcinoma, or fibroid tumors, it is contraindicated.

Heretofore, craniotomy has been deemed advisable in deformity of the pelvis with uniform contraction and a conjugata vera of from 8 cm. to 6½ cm., whilst in the pelvis with antero-posterior contraction, the flat pelvis, it was confined to a conjugata vera of 6½ to 5, and even 4, cm. Less attention has been paid to this operation of late, whilst the Cæsarean section has attained a wonderful development; hence the temporary predominance of the latter. Undoubtedly, with a proper application of antiseptic methods to embryotomy the mortality of this operation will be reduced. Nevertheless, the possibility of preserving fœtal life will lead to the adoption of the Cæsarean section in lying-in institutions, at least in those cases in which heretofore craniotomy has been performed, and the indications for the Cæsarean section will no longer be limited by a conjugate diameter of less than 4 or 5 cm.

*The Axis-Traction Forceps.*—It was to the French school, again, that we owe the introduction of this new forceps; it was from France that the forceps originally came; it was in France that the pelvic curve was added; and from France comes the new axis-traction instrument. The idea was not a new one: suggested by leather straps or towels attached to the lock, as indicated by Osiander, traction apparatuses were recommended by Herman in 1844, by Hubert in 1860, by Hartman in 1870, also by Moralis and Joulin, but it seems as if obstetricians had not been ready for the new departure, being still occupied with the perfection of the low-forceps operation. The instrument introduced by Tarnier in 1877 was the long French forceps with a tractor attached to the blades, an exaggerated pelvic curve, and a perineal curve. In England and America the idea was readily accepted, and modifications of the instrument soon appeared, the best of which are the forceps of Lusk of New York and of Simpson of Edinburgh, who merely added the tractor to the forceps of his uncle, Sir James Y. Simpson. Tarnier himself repeatedly modified his instrument, until it has of late again appeared in the form of the old Levret forceps without the exaggerated pelvic curve, with the addition of the tractor attached to the blades. In Germany the instrument found no favor, as the operation of version is preferred in those cases of somewhat contracted pelvis in which the high operation may be demanded.

The highest tribute is paid to the Tarnier forceps by Braun of Vienna, who testifies to the fact that in France the forceps operation is more fully developed than in Germany, and the obstetrician succeeds in the delivery of a living child in cases of such contraction where craniotomy is often resorted to in Germany.

The instrument invented by Breuss of Vienna, with a joint in the blade, has proven of no especial service.

### CONCLUSION.

Obstetric art has attained a most wonderful development during the last decade: this branch of medicine, being completely liberated from the confining bonds of surgery, and having attained full recognition as a distinct department of medicine, has advanced step by step with the progress of science. The use of anæsthetics for the purpose of mitigating the pangs of normal labor, long customary in America, is gaining ground abroad; the administration of ergot is confined to the uterus post-partum; the hot douche and the electric current have replaced more dangerous hæmostatics. The Cæsarean section has become an established, fairly safe operation, and promises to replace, in part at least, that fatal relic of the bloody period of surgical obstetrics, embryotomy; and the high-forceps operation, which followed in the wake of the axis-traction instrument, encroaches upon the sphere hitherto retained by craniotomy. Puerperal fever has been banished from lying-in institutions, which hitherto have been its breeding-place, epidemics have ceased, and sporadic cases only appear now and then.

The introduction of the prophylactic method has wrought a marvellous change in obstetric practice, which is well characterized by a comparison of results: in the New York Maternity, in 429 cases from 1882 to 1883, a mortality of 6 per cent. is noted; after the reform inaugurated by Garrigues we find a mortality of only 0.21 per cent. in 483 cases from 1885 to 1886. In the large clinics of Vienna, utilized freely by students and midwives, we find a mortality of .4 per cent.; in the Charité in Berlin in 1885 only 12 cases of puerperal fever in 1368 labors, .35 per cent., and 4 of these are readily accounted for, as one patient came into the house infected and a careless midwife carried the infection from this one patient to three others.

Leopold in Dresden had but 4 cases of infection occurring in the house in the course of two and a half years in 3196 labors, .012 per cent., and from May 1, 1886, to May 1, 1887, not a single one; moreover, during this year the patients there confined, after all operations, showed no elevation of temperature with the exception of 12.8 per cent. of the cases, which for one day indicated a rise of half a degree C.

Garrigues, in his *Antiseptic Midwifery*, tells us that by the antiseptic treatment of the nipples, and by compression in threatening cases, mastitis has entirely disappeared from the Maternity Hospital.

Tetanus neonatorum has almost ceased with the antiseptic treatment of the umbilical wound, and the purulent ophthalmia which has proved so destructive, and which seemed to be a necessary accompaniment of lying-in institutions, is eradicated by the simple proceeding of Crede.

This is certainly a most remarkable result, indicating to the thoughtful obstetrician the perfection to which his art may be carried.

But such results give rise to most uncomfortable reflections: such is the perfection of obstetric art in the hands of the masters of the art and in lying-in institutions, whilst in private practice, in the homes of comfort with the attendance of the best practitioners and the care of good nurses, many a young mother yields her life to the dangers which still accompany home confinement. We are told that the records of a prominent life-insurance company reveal a mortality of 17 per cent.[1] in private practice, and that is among the better classes. In the hospital all operations, including the most dangerous, are performed with scarce a rise of temperature; notwithstanding the gathering of patients from the poorest and filthiest surroundings, the proximity of surgical wards and medical cases of all kinds, puerperal fever is almost unknown. The hospital has become the place of greatest safety for the lying-in woman, whilst in her home she is still exposed to many of the dangers of parturition.

Why is this so?

First and foremost, it is the neglect of prophylaxis and of the necessary antiseptic precautions in private practice, by which the life of the parturient is endangered. The dangers of the hospital are evident, and have been overcome, but those which lurk in the home are more occult, and hence are ignored; the same care, the same cleanliness, should be exercised in hospital and residence. The introduction of the perfected prophylactic methods into private practice will prove the crowning glory of modern physiological obstetrics, and will at once reduce the fearful mortality of physiological labor to an imperceptible percentage. But there are other causes also.

The attention of the scientific obstetrician has been given wholly to abnormal labor, and the management of all such cases has been perfected to the utmost, whilst the care of normal labor, as it occurs in the great majority of private cases, is neglected. The parturient suffers under the continuance of the old prejudice that labor is a physiological act and should remain under the care of the midwife, whilst the physician sees only the pathological cases. In the hospital he controls them all, and hence the good results. Notwithstanding the excellent example of the control of natural labor by the medical man set by American practice, and now gradually received in the older countries, the practice of centuries and tens of centuries still remains firmly rooted among most peoples, and even in Germany, where surgical obstetrics has attained its utmost development, normal labor is still controlled by the midwife; if the physician is called, he does not seek to guide its course, but holds himself in readiness to interfere with the advent of pathological complications: he remains an idle spectator during the progress of normal labor. The unfortunate termination of these so-called normal labors is due in part to this prejudice and in part to the defective obstetric instruction in our schools.

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[1] [illegible] investigation has shown the mortality of confinement cases in general practice to be about 1 per cent.—[Ed.]

Serious injuries, if not fatal results, most frequently follow the so-called normal labors in private practice. Whilst the management of pathological labor has attained such perfection as to render almost any, even the most desperate, case promising in the hands of able obstetricians, so little attention has been paid to the correct guidance of what is termed normal labor that the terrors of childbed have been but little mitigated for the young mother confined in her home, even when under the most fortunate circumstances.

In Germany and France the facilities for instruction are abundant; in England and America they are but scant. In England the young physician is given a diploma and admitted to practice after a three months' course in midwifery (Simpson). Whilst theoretical teaching is all that can be desired in the United States, practical instruction is but limited, notwithstanding the noble efforts of James P. White, the pioneer in obstetric teaching, who braved the wrath of his colleagues and his fellow-citizens when he established the first obstetric clinic in the United States in his home in Buffalo, N. Y. The student is taught the management of pathological cases, but how to guard his patient against their occurrence, the practical management of simple labor, examination, and manipulation, he must learn by experience; and not until the proper guidance in normal labor, a physiological, prophylactic, and antiseptic obstetrics, is thoroughly taught, practically and theoretically, will the results of private obstetric practice equal those of the hospital, which are far better under circumstances far worse.

The efforts of the obstetric teacher must now be directed to practical instruction in the lying-in room, to the perfection of the management of normal labor, and the introduction of antiseptic methods into private practice as they have been received in the hospital.

# TABULAR VIEW OF THE HISTORY OF OBSTETRICS.

## I. EMPIRICAL OBSTETRICS.

Obstetric practice in the hands of women; disregard of fœtal life; ignorance of anatomy and physiology; the cephalic presentation the only hopeful one; labor is supposed to be a voluntary act on the part of the child, and the abdominal muscles are the propelling power.

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| *a. Primitive or Intuitive Epoch.* | The obstetric practice of primitive peoples from prehistoric times to the present day. | Assistance, if any, rendered by women, by neighbors and friends; the efforts of nature furthered by varying posture of the patient, by massage and pressure and nauseating internal remedies; forcible expulsion by abdominal pressure in support of the natural *vis a tergo* is the last resort. |
| *b. Religious Epoch.* | The obstetric practice of the semi-civilized nations of the present day most fully developed in the earlier periods of India, Egypt, and Greece; terminating in Greece 400 B. C. | Assistance rendered by women; empirically-educated midwives appear; in difficult labors the priesthood is appealed to, who give spiritual (Arabs, Florida Indians, Bashkirs) or mechanical aid (early period of Egypt and of Greece).<br>The practice is similar to that of the Intuitive Epoch: pressure and external manipulations in support of the natural *vis a tergo;* internal medication by purgatives and vomitants; excellent obstetric precepts are given in religious laws and customs; the presentations are diagnosed; cephalic presentations alone are hopeful; instruments for the destruction of the fœtus appear. |
| *c. Advanced Pre-anatomic Epoch.* | 400 B. C. to 1550 A. D., the status of obstetric art in India and in Egypt, when at the height of their civilization, in Greece after Hippocrates, carried by the Arabs to the East and to the West, continuing in Europe to the middle of the sixteenth century, persisting at the present day in China and Japan. | Obstetric practice in the hands of women; the aid of medical men sought in difficult cases; an external anatomical knowledge of the pelvis is obtained.<br>Cephalic presentations alone are hopeful; cephalic version is attempted; embryotomy is the last resort.<br>Intuitive manipulations disappear; the obstetric chair and numerous instruments for the destruction of the child are devised; the work of the medical practitioner is altogether surgical, as he is not called until after the death of the child; and obstetric art is taught as a branch of surgery. |

## II. SCIENTIFIC OBSTETRICS.

Obstetric practice in the hands of the physician; the obstetric art accepted as an independent branch of the medical sciences, distinct from surgery; scientific development of the art upon an anatomical and physiological foundation; preservation of fœtal life a fundamental principle.

| | | |
|---|---|---|
| 1550–1800. *a. Period of Development. — Surgical Period.*<br>Prevalence of early surgical influence. | From the discovery of—<br>1. Podalic Version, 1550–1647, to the introduction of the forceps. | Rediscovery of podalic version by Paré, 1550; anatomy of the pelvis described by Vesalius, 1543; Cæsarean section performed by Rousset, in Paris, 1581; *Midwifery* of Louise Bourgeois published, 1600; circulation of the blood discovered by Harvey, 1628; beginning of anatomical research. |
| | From the introduction of the—<br>2. Forceps, 1647–1754, to their perfection by the pelvic curve. | Introduction of the straight forceps by Chamberlaine, 1647; first *Midwifery* published by Mauriceau, 1668; first obstetric chair established in the Hôtel Dieu in Paris by Gregoire, 1720; discovery of the forceps by Palfyn, 1721.<br>1753, the instrument of Roonhuyzen made public property; the lever devised by Roonhuyzen; obstetric chairs established in all large schools, first in England and France, later in Germany. |
| | 3. 1754–1800. Perfection of the forceps to the beginning of the Physiological Epoch. | 1754, pelvic curve given to the forceps by Levret.<br>1754, mechanism of labor described, and the first correct measurements of the pelvis made by Smellie.<br>1756, inauguration of premature labor suggested to replace Cæsarean section and craniotomy; carried out in England, 1768.<br>Symphyseotomy performed, 1777; Hunter and Boerhaave inaugurate the physiological study of labor, 1768; Casp. Fried. Wolff, first embryological study.<br>1771, appearance of Solayres' physiology of parturition; beginning of modern obstetric principles: the observation of nature, and resort to artificial means only if nature fails. |

| | | |
|---|---|---|
| 1800–1888. *b. Period of Perfection.* — *Physiological Period.*<br>**Progress of physiology; development of pathological anatomy; gradual limitation of craniotomy; study of physiological labor.** | 1. Physiological Period, 1800–1847. Instrumental interfering obstetrics of Levret and Smellie yield to the physiological practice of Solayres and Baudelocque. | Perfection of the low-forceps operation; instrumental interference limited more and more to definite indications; the obstetric chair passes away; increased opposition to craniotomy; craniotomy replaced in part by the forceps in England and France, by version in Germany, and the reappearance of the operation for the induction of premature labor, 1831; introduction of ergot by Stearns of New York, 1807; embryological work of Meckel, 1812.<br>Teachings of Baudelocque characterize this period, to allow nature to complete labor if possible, and interfere only if nature fails. |
| | 2. Discovery of anæsthesia and the infectious nature of puerperal fever, 1847–1870. | Discovery of ether by Morton in 1841; application of anæsthesia to obstetric practice by Simpson, 1847, and Channing, 1848; infectious nature of puerperal fever suggested by O. W. Holmes, 1845; demonstrated by Semmelweiss, 1847; combined version introduced by Wright of Cincinnati and Braxton Hicks of London, 1854. |
| | 3. Antiseptic Era, 1870–1880. Prevalence of carbolic acid and prophylactic vaginal and intra-uterine injections.<br>1880–1888. Prevalence of corrosive sublimate and aseptic prophylactic methods. | Perfection of the high-forceps operation; utmost limitation of craniotomy; introduction of antiseptic method in obstetric practice by Stadtfeldt of Copenhagen, 1870; prevalence of carbolic acid; prevalence of active measures and intra-uterine injections; introduction of Porro's operation, 1876; of Tarnier's axis-traction forceps, 1877; of the bichloride of mercury by Tarnier, 1881; prevalence of prophylactic or aseptic practice and the use of the bichloride; prophylactic vaginal and intra-uterine injections proven dangerous and unnecessary; perfection of the conservative Cæsarean section by Saenger, 1884. |

## NOTE TO ARTICLE ON HISTORY OF OBSTETRICS.

Misled by the universal acceptance of the erroneous statement that the first step toward the introduction of *aseptic* obstetrics, and the abandoning of the overdone meddlesome, and dangerous *antiseptic* practice, was due to Runge, assistant to Prof Gusserow, and Hofmeier, assistant to Prof. Schroeder, I have made the same assertion repeating it, as other authors have done, without further investigation.

The step was one of such import, and of such influence upon the future of obstetric science, that it is but right that the prevailing error should be corrected and the merited honor properly given to the deserving obstetrician by whose judgment the dangerous tendencies of the violent prophylactic antiseptic practice were checked and the correct aseptic inaugurated.

It was Runge who first denounced the then prevailing prophylactic as well as therapeutic use of the intra-uterine douche: his paper, based upon observations in Prof. Gusserow's obstetric wards in the Charité, appeared in the *Berliner klinische Wochenschrift*, 1880, Nos. 43–46, and in the *Zeitschrift für Geburtshülfe*, vol. v., 1880, p. 195; also *Volkmann*, No. 237.

In consequence of the advanced position taken by Runge, Gusserow was denounced, and for a time the prophylactic douche, as still advocated by the followers of Schroeder, continued its sway.

Not until a later date did Schroeder withdraw from his dangerous course, and then his assistant, Hofmeier, gradually acknowledged the dangers of the prophylactic method and appeared as an advocate of the aseptic practice previously adopted in the wards of Prof. Gusserow. Possibly an article by Hofmeier (*Zeitschrift für Geburtshülfe*, 1880, vol. v. p. 175) questioning the value of the prophylactic, but upholding the therapeutic, douche may have given rise to the coupling of his name with that of Runge as an instigator in the aseptic movement.

In the face of opposition and ridicule, especially on the part of Hofmeier, Runge abandoned the prophylactic douche and outlined the more reasonable aseptic practice which has long since been everywhere accepted, and to him should be given the credit as being the pioneer among German obstetricians.—(*See p. 59.*)

# THE PHYSIOLOGY AND HISTOLOGY OF OVULATION, MENSTRUATION, AND FERTILIZATION: THE DEVELOPMENT OF THE EMBRYO.

By H. NEWELL MARTIN, F. R. S., M. D., D. Sc., M. A.,

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## I. OVULATION.

INTRODUCTORY.—In this article an attempt will be made to give a short account of the phenomena of ovulation, menstruation, and embryonic development from the standpoints of the morphologist and physiologist. The practical bearings of the facts or the theoretical views which may be put forward are, for the most part, left to be treated of by other contributors to this volume.

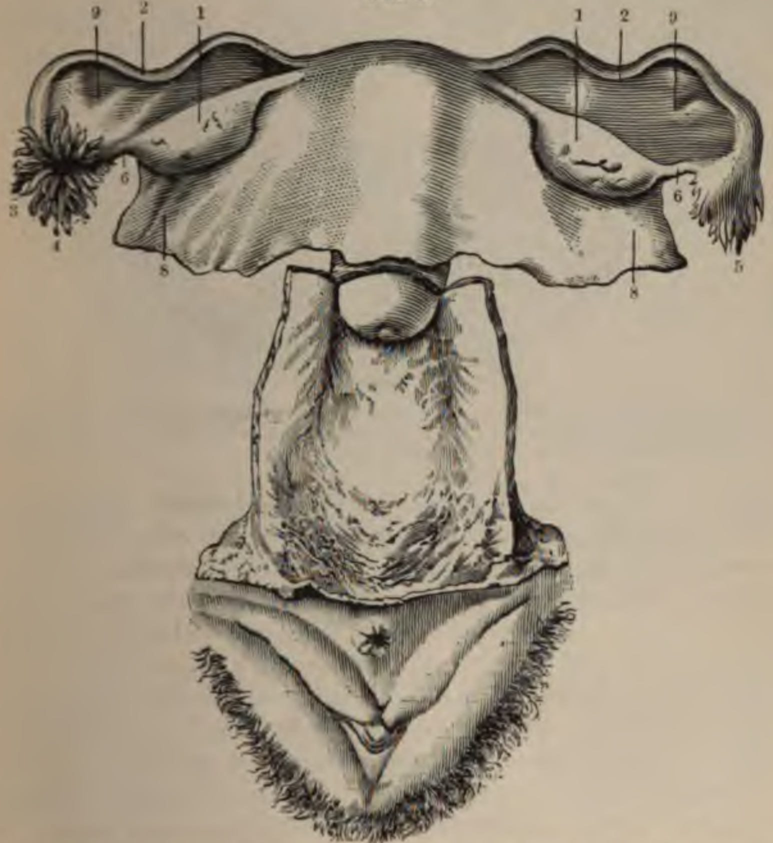
"Life is a cycle beginning in an ovum [or spermatozoon], and coming back to an ovum [or spermatozoon] again." Any but an incidental discussion of the origin and nature of the spermatozoon would be beyond the limits allotted us. We shall therefore commence with the ovum; next, consider the uterine processes (menstruation) which prepare the uterus to nourish the fertilized egg; and conclude with a brief account of the development of the embryo up to the time of the origin in it of new ova.

*Structure of the Ovaries.*—The adult ovaries are dense fibrous ovoid masses, usually weighing about 5.5 grams (78 grains). They are somewhat flattened in one of their transverse diameters, the average measurements of the three diameters being 38, 19, and 13 millimeters (1½, ¾, ½ inch), respectively. Each ovary is attached by one border to the broad ligament of the uterus; its opposite border and both flattened sides are free. The attached border is named the *hilus*, and along it vessels and nerves enter and leave the organ. One of the processes or *fimbriæ* of a Fallopian tube is adherent to the outer upper end of each ovary (Fig. 1).

The ovary may be described as consisting of a ground substance or *stroma;* of egg-containing cavities, the *Graafian follicles,* scattered through the stroma; of an *epithelium* covering the ovarian surface except at the hilus; and of blood-vessels, lymphatics, and nerves.

*The Ovarian Epithelium.*—The broad ligament is covered by simple scaly epithelium resembling that on the surface of other parts of the peritoneum, and presents a smooth, glistening surface. In young adults the epithelial surface of the ovary is also smooth, but it presents a duller, less shiny surface. This difference of appearance is correlated with the fact that the epithelium covering the ovary differs in structure from that of the general peritoneum: it is made up of a layer of cylindrical or columnar cells, and in the embryo very early assumes this special character, and is set apart for the formation and nourishment of ova (see p. 195). This function it probably retains to some extent until the procreative life of the woman has ceased, as among

FIG. 1.

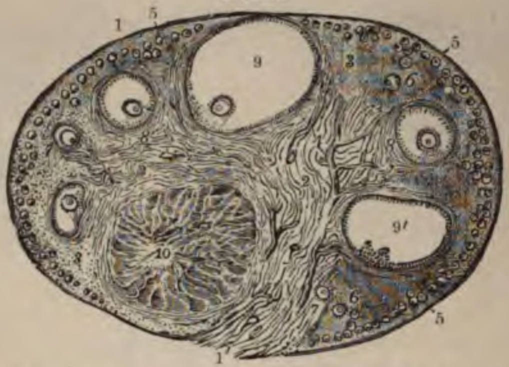


**Female Organs of Generation from behind (from Quain, after Sappey): 1, ovaries; 2, Fallopian tubes; 3, 4, 5, fimbriated extremities of the Fallopian tubes; 6, ovarian fimbria; 8, 9, broad ligaments.**

its cells one can usually find, until the climacteric, some which are larger and rounder than the rest, and closely resemble the embryonic primordial ova.

*The Stroma* of the ovary consists fundamentally of a close feltwork of white fibrous and yellow elastic connective tissues richly supplied with nucleated corpuscles. The majority of the latter are spindle-shaped, but in the neighborhood of the blood-vessels there may be found numerous polyhedral or irregularly-shaped cells, which often contain yellow pigment: these are the so-called *interstitial cells*, and increase in number and are more widely distributed through the ovary as age advances. Immediately beneath the epithelial layer the fibrous stroma is especially dense, forming a thin, very tough stratum. This has been called the *tunica albuginea ovarii*, but it insensibly grades off into the deeper layers of the stroma, and does not form a distinct separable coat comparable to the tunica albuginea of the testis.

FIG. 2.

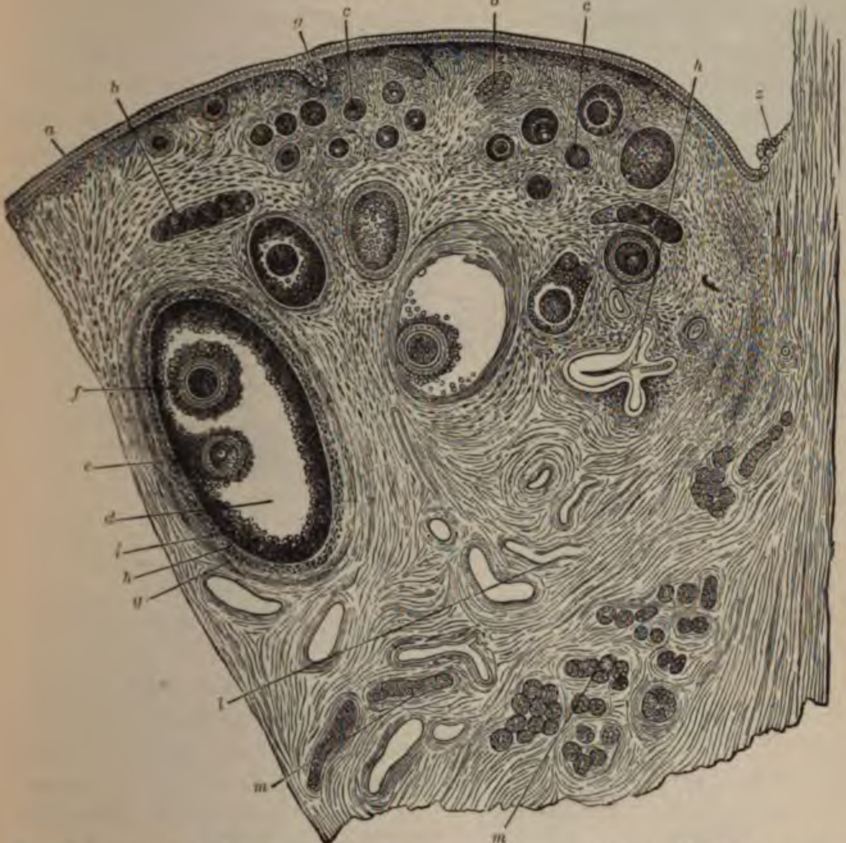


Section of Ovary of Cat (Schrön): 1, outer covering and free border of ovary; 1', hilus; 2, 3, ovarian stroma; 4, blood-vessels; 5, young Graafian follicles; 6, 7, 8, more mature follicles; 9, a follicle nearly ripe; 10, corpus luteum.

Along the hilus, blood-vessels, lymphatics, and nerves enter and leave the ovary: they branch through the stroma, forming part of it. The arteries and veins are comparatively large at the hilus and in the centre of the ovary, but divide into minute twigs near the surface. A certain amount of plain muscular tissue lies near the arteries.

*The Graafian Follicles*, or egg-chambers, are numerous. In the ovaries of a newborn female infant there are about seventy thousand of them, and probably additional ones are developed during life. From their size and arrangement they fall into two groups: the smaller and simpler are closely packed just beneath the *tunica albuginea*, and constitute the *cortical layer* of the ovary. In this layer most of the follicles have a diameter of about one-fourth of a millimeter ($\frac{1}{100}$ inch); they have no differentiated enclosing capsule, and consist merely of a

FIG. 3.



Section through Part of Ovary of Adult Bitch (from Waldeyer): *a*, germinal epithelium; *b*, ingrowths (egg-tubes) from the germinal epithelium, seen in cross-section; *c*, *c*, young Graafian follicles in the cortical layer; *d*, a more mature follicle, containing two ova (this is rare); *e* and *f*, ova surrounded by cells of discus proligerus; *g*, *h*, outer and inner capsules of the follicle; *i*, membrana granulosa; *l*, blood-vessels; *m*, *m*, parovarium; *g*, germinal epithelium commencing to grow in and form an egg-tube; *z*, transition from peritoneal to germinal epithelium.

spherical case of cells which closely invest, and presumably nourish, the young ovum.

In the least developed follicles the investing cells are flattened (*a*, Fig. 4); the ovum has no cell-wall, and consists merely of a minute mass of mixed protoplasmic and nutritive material forming the cell-body or yolk or *vitellus*, *b*, containing a cell-nucleus or *germinal vesicle*, *c*, within which is a well-marked nucleolus or *germinal spot*, *d*.

*Origin of the Graafian Follicles.*—Many Graafian follicles are formed during early embryonic life by ingrowths from the germinal epithelium covering the ovary, but the process continues until the age of child-bearing has passed. Rows or cords of cells burrow (*g*, Fig. 3) from

FIG. 4.

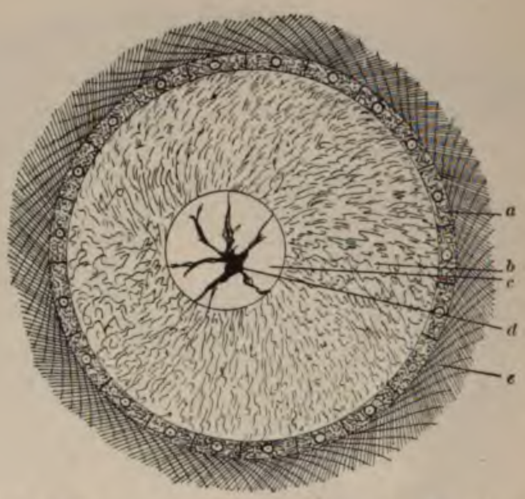
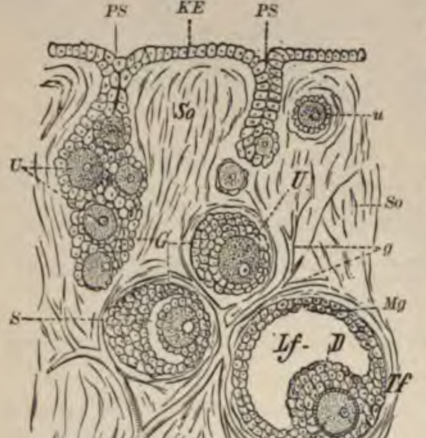


Diagram representing Structure of Young Graafian Follicle: *a*, investing cells; *b*, vitellus; *c*, germinal vesicle; *d*, germinal spot; *e*, ovarian stroma.

the epithelium into the stroma of the ovary. In these egg-cords certain cells, *the primitive ova* (Fig. 5), enlarge and become more granular and rounder than the rest. Ingrowths of the stroma next cut off the connection between the egg-cord and the epithelium, and also divide the cord up into a number of pieces, each containing a primitive ovum (rarely two) surrounded by a number of investing cells. Thus from each cord a number of young Graafian follicles are developed. Some of the stages of the process are represented in Fig. 5.

FIG. 5.

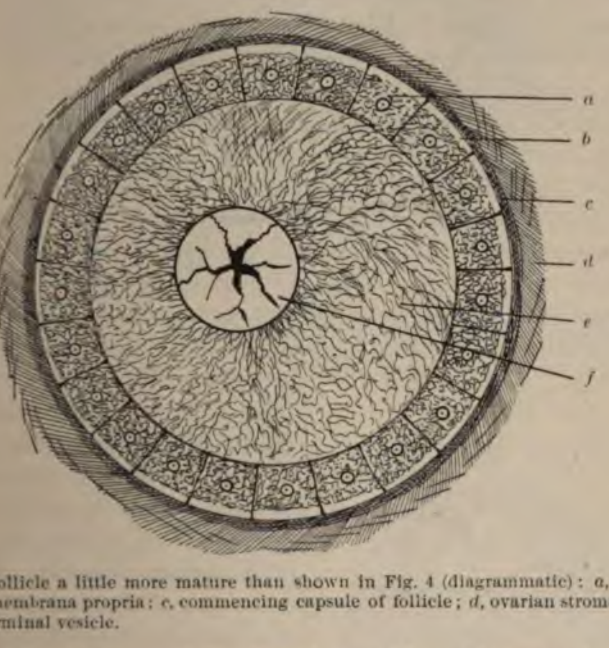


Section through Part of a Mammalian Ovary (after Wiedersheim): *KE*, germinal epithelium; *PS*, an egg-cord; *U*, primitive ova; *G*, investing cells; *K*, germinal vesicle; *S*, follicular cavity arising in one of the older follicles; *Lf*, follicular cavity, more enlarged; *Ei*, nearly mature ovum, which has developed around it the zona pellucida, *Mp*; *Mg*, membrana granulosa; *D*, discus proligerus; *So*, ovarian stroma; *Tf*, capsule of follicle.

When a follicle commences to ripen it recedes from the surface of the ovary and increases in size, and also becomes more complex in structure. Just below the cortical layer one finds in the normal adult ovary follicles, the investing cells of which are cuboidal; at their outer ends is a thin transparent layer, the *membrana propria*, which separates them from the stroma (Fig. 6). The stroma itself is somewhat condensed, and its fibres more closely interwoven immediately around the follicle, and thus forms a sort of *capsule* for it. As maturation of the follicle proceeds, the investing cells become columnar, and then they multiply and become two layers thick, so that the ovum becomes invested by two layers of cells, by a *membrana propria*, and by a fibrous capsule. The inner layer of the investing cells is probably formed by division of the cells of the primary single stratum.

In riper and more deeply-placed follicles the cells of both investing layers are found to have multiplied, and a considerable quantity of albuminous liquid (*liquor folliculi*) to have collected between them (Fig. 5, *l.f*), except at one region: there the cells cohere, and the ovum is always situated at this place. It thus comes to be excentric in position within the Graafian follicle, the side which it lies next being usually that nearest the surface of the ovary. The cells (*Mg*, Fig. 5) which line the follicle constitute the *membrana granulosa;* those which immediately invest the ovum form the *discus proligerus* (D, Fig. 5).

FIG. 6.



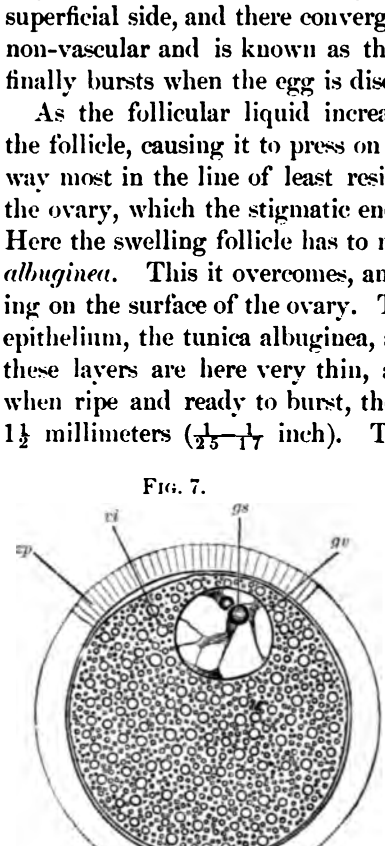
A Graafian Follicle a little more mature than shown in Fig. 4 (diagrammatic): *a*, investing cells; *b*, membrana propria; *c*, commencing capsule of follicle; *d*, ovarian stroma; *e*, vitellus; *f*, germinal vesicle.

The follicular liquid contains a form of proteid named *paralbumen*, which differs from ordinary proteids in that it is not coagulated and rendered insoluble in water when precipitated by alcohol. Paralbumen has been found in ovarian cysts.

The maturing follicles increase rapidly in size, partly from the multiplication of the cells within them, but mainly because of the accumulation of follicular liquid. The liquid is probably not a mere transudation, but a true secretion of the cells of the *membrana granulosa.* Meanwhile, the more condensed layer of stroma, which was recognizable as a sort of capsule around less advanced follicles, becomes very distinct and separates into two layers—an inner, very rich in capillary blood-vessels, and an outer, dense and tough and containing arterioles and small veins. The blood-vessels in neither layer spread all the way round the follicle. They become less numerous near its more superficial side, and there converge toward a small area which is entirely non-vascular and is known as the *stigma.* At the stigma the follicle finally bursts when the egg is discharged.

As the follicular liquid increases, the tension exerted by it distends the follicle, causing it to press on the surrounding tissues. These give way most in the line of least resistance—that is, toward the surface of the ovary, which the stigmatic end of the ripening follicle soon reaches. Here the swelling follicle has to meet the resistance of the tough *tunica albuginea.* This it overcomes, and pushes it out so as to form a swelling on the surface of the ovary. This swelling is covered by the ovarian epithelium, the tunica albuginea, and the walls of the follicle; but all these layers are here very thin, and contain few or no blood-vessels: when ripe and ready to burst, the follicle has a diameter of from 1 to 1½ millimeters ($\frac{1}{25}$–$\frac{1}{17}$ inch). The *discus proligerus,* with the ovum imbedded in it, usually lies near the outermost end of the projecting follicle. Observations on the lower animals show that follicles in this condition are very easily burst, and that they then extrude the follicular liquid, which carries with it the ovum and some of the cells of the discus proligerus and membrana granulosa.

FIG. 7.



Nearly Ripe Ovum of Cat (semi-diagrammatic): *zp,* zona pellucida or zona radiata; *vi,* vitellus; *gv,* germinal vesicle; *gs,* germinal spot. (After Schäfer.)

*The Egg-membranes, or Coats of the Ovum.*—While the Graafian follicle has been distending and ripening, the egg, buried in the discus proligerus, has developed three coats or cell-membranes. By far the most distinct of these in the mammalian ovum, and the longest known, is a translucent radially-striated membrane, the *zona radiata* or *zona pellucida, zp* (Fig. 7).

Outside the zona radiata is an irregular granular membrane, which is the first-formed cell-wall of the ovum, and is known as the *vitelline membrane* (*c*, Fig. 8). Inside the zona is a delicate membrane, the third proper coat of the ovum, which only develops as the ovum approaches maturity (*e*, Fig. 8). The diagrammatic representation in Fig. 8 may help to the understanding of the structure of the ovum and of its relationship to the follicle at this stage, but it must be borne in mind that the figure is a mere diagram. It represents a section through part of a nearly mature Graafian follicle, passing through the ovum and discus proligerus.

FIG. 8.

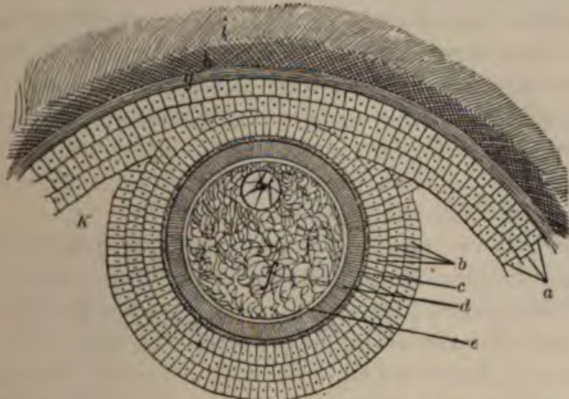


Diagram of Section through nearly Mature Ovum and Part of Graafian Follicle: *a*, cells of membrana granulosa; *b*, cells of discus proligerus; *c*, vitelline membrane; *d*, zona pellucida; *e*, internal cell-membrane of ovum; *f*, vitellus; *g*, inner vascular layer of capsule of follicle; *h*, outer fibrous and less vascular layer; *i*, general ovarian stroma; *K*, follicular cavity filled with follicular liquid.

*The Properties of the Unfertilized Ovum.*—In early stages of its development the ovum, as already stated, consists of a mixed mass of protoplasm and food-material, the *vitellus*, imbedded in which is a germinal vesicle containing a germinal spot. The protoplasm has the faculty, possessed only by living matter, of taking up other substances (foods) into itself and transforming them into matter like itself and possessing the same properties. Egg-protoplasm has in addition the tendency and the faculty to constrict and divide along certain lines, and thus to separate into two or more pieces, which become distinct living units or *cells*. This tendency to division or *segmentation* of the ovum is greatly increased by *fertilization* (p. 97), and then leads to the formation of the embryo. The other chief constituent of the vitellus, the food-material, is constantly supplied by the cells surrounding the young ovum: it is usually granular, and gives the whole vitellus its cloudy, semi-opaque appearance, the pure protoplasm being transparent and showing no structure when examined with the microscope. There may also be in the egg, mixed with the protoplasm, waste matters produced by the breaking down of protoplasmic material, as a result of its activity. The food and other matters mixed with the protoplasm are named collectively *deutoplasm* or *paraplasm*.

*Holoblastic and Mesoblastic Ova.*—In all eggs the absolute quantity of genuine protoplasm is small: in the human ovum and in the eggs of the higher mammals there is also but little deutoplasm. The whole ovum in such cases is microscopic in bulk, and the protoplasm is tolerably evenly diffused throughout it. When ova of this type segment after fertilization, they divide completely into a number of similar cells, and these cells live and multiply for a time by using the deutoplastic food-material which each contains. But the quantity of deutoplasm being small, the segmenting egg ( = young embryo) has soon to seek food from other sources; for example, in the higher mammals from the secretions of the Fallopian tubes and the mucous membrane of the womb, and later from the placenta.

The actively-living, segmenting, and assimilating protoplasm of an egg has been distinguished, under the name of *germ-yelk*, from the secondary food-material (deutoplasm), which is known as the *food-yelk*.

In the eggs of many animals the quantity of food-yelk is vastly in excess of that of the germ-yelk. In such cases most of the germ-yelk is collected at one point near the surface of the vitellus, the rest of it being distributed as a wide-meshed reticulum which holds together the granules of the food-yelk. In these eggs the concentrated germ-yelk alone segments, and the new cells to which it gives origin by division gradually absorb and assimilate the great mass of food-yelk. The embryo is thus nourished by material stored in the egg, as in the typical instance of a hen's egg, in which the developing chick needs no extraneous supply of any kind of food, except oxygen, until after it is well developed and has been hatched. Lime salts from the shell, albumen and salines from the white, albumens and fats from the food-yelk, are all taken up and assimilated by the developing chick. In such cases no placenta is formed, and the uterus, after taking its share in the formation of the white and shell of the egg, has nothing further to do with the nutrition of the embryo.

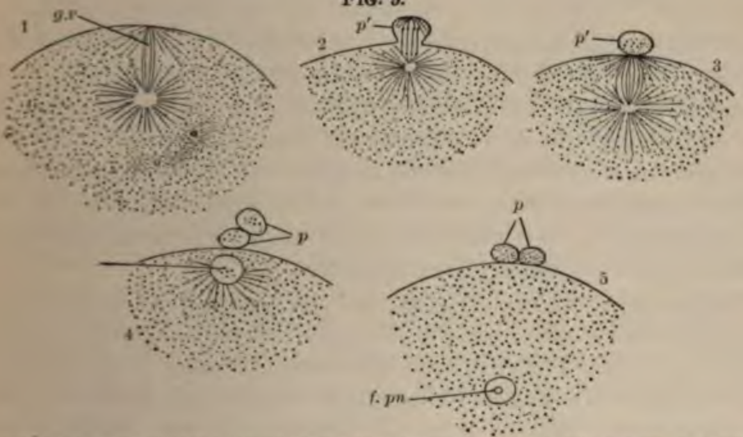
An egg which completely segments is *holoblastic*; one which partially segments, leaving some unsegmented food-yelk to be later absorbed by the embryo cells, is *mesoblastic*. The human ovum is holoblastic.

Comparative embryology shows that there is no sharp dividing-line between mesoblastic and holoblastic ova. In the egg of the frog, for example, a considerable proportion of food-yelk is present, but not enough to prevent complete segmentation. However, there is a much larger proportion of it in one-half of the egg than in the other; and this half segments more slowly and forms larger cells than does the other half, richer in germ-yelk. Many other intermediate stages between the two chief types of ova might be given.

*The Maturation of the Ovum.*—The details of the ripening of the ovum and its preparation for fertilization have not yet been directly observed in human ova; but from what has been seen to occur in eggs of a large number of the lower animals, we may safely conclude that the process is as follows:

The germinal vesicle or nucleus elongates in a radial direction, and as a whole moves toward the surface of the egg. It loses its definite boundary, and the germinal spot also becomes indistinct. Indeed, according to older embryologists, the germinal vesicle and spot entirely disappear: it is only advances in histological technique made during the last twenty years which enable the nucleus to be detected at this stage. As the nucleus elongates (Fig. 9) the egg-protoplasm near the nuclear poles shows a radial arrangement, the radii converging toward each pole, while striations unite the two poles. This phenomenon is now well known as occurring in the phenomenon of nuclear division as preliminary to ordinary cell-division: the germinal vesicle and the germ-yelk behave exactly like the nucleus and protoplasm of any normally dividing cell. The phenomenon is named *karyokinesis*, and cannot here be described in detail. The lines uniting the poles of the nucleus disappear, and the nuclear matter collects at each pole, forming two new nuclei, around each of which the germ-yelk still shows a radial arrangement. The result is a couple of star-like figures (Fig. 10), and is known as the "amphi-aster" stage in nuclear development.

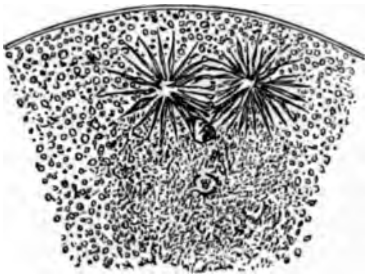
**FIG. 9.**



Stages in the Formation of the Polar Globules in an Ovum (after Hertwig): *g. v*, germinal vesicle or egg-nucleus undergoing karyokinesis; *p'*, the first polar globule in process of extrusion, and (3) extruded; *p*, both polar globules extruded; *f.pn*, female pronucleus.

In the ovum one of the new nuclei moves to the surface, and is extruded along with a small amount of the egg-protoplasm, the extruded nucleus and its accompanying protoplasm being known as the first *polar globule*. The process is then repeated, and a second polar globule extruded (*p*, Fig. 9). There can be no doubt that the phenomenon is a true cell-division, exhibited by the unfertilized ovum, and in some way preparatory to fertilization. The egg divides into a large cell and two small cells; the latter, or polar globules, contain some of the nucleus and some of the protoplasm of the original egg-cell, and are not known to play any further part in the development of the embryo. The larger cell resulting from the division becomes the mature ovum. That portion of the original nucleus remaining in it recedes from the surface; it soon assumes all the optical characters of an ordinary germinal vesicle, with its nucleolus, and the radial arrangement of the yelk surrounding it is lost: in this condition it is known as the *female pronucleus*. We shall show later, in more detail, that the fundamental fact in fertilization of the ovum appears to be the fusion of a *male pronucleus*, derived from the body or head of a spermatozoon, with this female pronucleus, found in the egg after extrusion of the polar globule.

FIG. 10.



An Ovum in the Amphi-aster Stage (Balfour, after Fol).

That the segmentation of the egg-cell and extrusion of the polar body, as a preliminary to the capacity of the egg to be fertilized, have a meaning, no one can doubt. They may be mere remnants of some ancestral process which occurred in primitive living matter; and the fact that polar bodies are found both in plants and animals indicates that they originated very early in the evolution of living things. But, granting this, we may fairly assume that had the process no practical physiological importance, it would, in the course of evolution, have been eliminated from the developmental history of the higher plants and animals; and this we know not to be the case. There is, in fact, as yet no satisfactory theory as to the meaning of, or the reason for, the formation and separation of the polar bodies.

The main theories maintained are: 1. The polar bodies are merely matter useless to the ovum and excreted by it (Bütschli, Strasburger, Hertwig). 2. (Minot, Balfour.) The removal of the parts of the nucleus and protoplasm carried off in the polar bodies leaves the ovum an incomplete cell, requiring for its completion and further development and multiplication new nuclear and other protoplasmic matter from outside, thus making possible the fusion and co-operation of the male element, and facilitating cross-fertilization, with its beneficial results.

The lower animals and plants frequently multiply without any sexual process. The organism, usually unicellular, divides up in some one of several known methods into two or more cells which become independent individuals. In the higher plants and animals the individual cells which cohere to compose the whole complex mass, and which, nevertheless, have their own more or less independent life, usually multiply in this *asexual* manner. The definition of *sexual reproduction* is the coalescence of materials derived from two cells as a necessary preliminary to the formation of a new individual of the species. In nearly all the more complex, or multicellular animals, growth is effected by asexual cell-multiplication; but reproduction is effected by a sexual process; by the fusion of material derived from two cells. In certain cases, however, even in complex animals and plants, what is known as *parthenogenesis* occurs; that is to say, a reproductive cell resembling an ovum multiplies and develops a new individual without fertilization. It is noteworthy that parthenogenetic development is frequent in insects and wheel-animalcules, and that it is in exactly these groups that the separation of a polar body from the ovum is still in doubt. This fact may perhaps be taken provisionally as an evidence that the extrusion of a polar body is antagonistic to parthenogenesis. Balfour therefore suggests that *the function of forming polar cells has been acquired by the ovum for the express purpose of preventing parthenogenesis.* Parthenogenesis of the ovum would result in the closest kind of in-breeding, and the ill results of this and of self-fertilization when continued have been long recognized, and have been satisfactorily explained by Darwin.[1]

*Ovulation, or the Discharge of the Ripe Ovum.*—While the egg is ripening the Graafian follicle travels toward the surface of the ovary, and becomes larger and more tensely filled by liquid. Finally, it projects from the surface of the ovary. Its wall is thinnest at its most prominent part, and at this place contains no blood-vessels. This projecting, thinnest, and non-vascular part of the coat of the follicle is known as the *macula* or *stigma*. It finally bursts, and the ovum is discharged along with the follicular liquid, and still imbedded in the cells of the discus proligerus.

The ripening and discharge of ova is a periodic process. In many of the lower animals it only occurs at intervals of a year or a month or a week, and the female only at these epochs exhibits sexual appetite, and will only then permit the access of the male. Except in the human female and in a few races of domesticated animals, ovulation occurs in mammals at certain seasons of the year only, and these seasons are correlated with the duration of pregnancy in the species, so that the young shall be born at a time when the food-supply of the parents in their native haunts is most likely to be abundant. In the human race there is reason to believe that ova are especially apt to ripen and to be discharged at or about the menstrual epochs, though there is evidence that eggs may occasionally mature and be set free in intermenstrual periods. In other words, the activity of the ovary which results in ovulation, and the activity of the uterus which results in menstruation, in the vast majority of cases have the same period and nearly coincide in time of occurrence; but either may take place without the other in exceptional instances.

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[1] *Cross- and Self-fertilization in the Vegetable Kingdom.*

Whether copulation has any influence in promoting the discharge of the ovum is a question which cannot be yet satisfactorily answered. It is certain that ovulation may and does occur and recur regularly without sexual congress in mammals: if sexual congress has any influence, it can only be a mere hastening of a normal periodic process; that ovulation can be so hurried is not proven.

The main arguments in favor of the view that sexual congress promotes the ripening or discharge of ova are these: *a.* In some plants (*orchids*) the ovaries only ripen weeks or months after the pollen-grains have been deposited on the stigma and sent forth their pollen-tubes toward the ovary. *b.* Clarke[1] observed that one of the tortoises (*Chrysemys picta*) laid fertile eggs only when eleven years old, but for several previous years copulated twice annually. From this Clarke concluded that sexual congress promotes the ripening and discharge of ova. Something similar has been observed in a few other animals (Coste,[2] Schneider[3]). But these must be regarded as exceptional cases yet to be explained: in the vast majority of animals and plants the ova ripen quite independently of sexual congress. An acute sexual orgasm in the woman may lead to the slightly premature bursting of ripe Graafian follicles and to conception; but there is no good reason for believing that, so far as the human female is concerned, sexual congress has any important influence on the maturation or discharge of ova ready for fertilization.[4]

*Reception of the Discharged Ovum by the Fallopian Tube.*—In most animals the oviduct is a mere duct continuous directly with the ovary, and carrying off the eggs and all other matters secreted by that gland. But in the higher vertebrates and in many invertebrates this is not the case: in them the oviduct is not directly continuous with the cavity of an egg-secreting gland, but is a separate and distinct tube, known as the *Fallopian tube.* In the mammals (including the human race) the Fallopian tubes, which are two in number (right and left), meet and form a single cavity, the *uterus.* In the uterus the layer of involuntary or unstriped muscular tissue present in the walls of the Fallopian tubes

[1] *Contributions to Natural History*, edited by L. Agassiz, ii. p. 490, Boston, 1867.

[2] *Histoire du Développement*, ii. p. 84.

[3] *Unters. über Platelminthen*, 1873, p. 40.

[4] See Hensen in *Hermann's Handbuch der Physiologie*, vol. vi. pt. ii. p. 58.

is greatly increased in quantity, and becomes vastly more complex in its anatomical arrangement. The mucous membrane lining the Fallopian tubes is also much altered when those tubes coalesce to form the womb: it becomes thicker, glandular, and very vascular, and will be described in more detail subsequently (p. 83). From the uterus a single tube in the higher mammals (with exceptions in some species of the hare family) leads to the exterior. This tube, the *vagina*, receives the male element necessary to fertilization of the egg, and transmits it to the uterus, and through this to the Fallopian tubes, where it meets the ovum. Fertilization may occur even before the egg enters the Fallopian tube and while it still lies on the surface of the ovary, as is proved by cases of extra-uterine pregnancy. It normally occurs at the upper end of a Fallopian tube.

In the great majority of cases the ripe egg discharged by the ovary is taken into a Fallopian tube, and by the latter conveyed to the womb. If not fertilized on its way to the womb, it develops no farther, and breaks down and is discharged through the vagina. If fertilized, it passes through the first stages of development in the Fallopian tubes, and, slowly reaching the uterus, applies itself to some part of its lining mucous membrane and develops an organ, the placenta, in which the fœtal and maternal blood-vessels are so closely intertwined that by dialysis the blood of the maternal uterus carries off the wastes of the fœtus, which are returned to the external universe by the skin, lungs, and kidneys of the mother. On the other hand, the fœtus gets nourishment from the maternal blood. The uterus of the higher mammalia is an organ designed to nourish the developing fertilized ovum, which, unlike the bird or reptile egg, has very little food in it for its sustenance in the earlier stages of its development. The Fallopian tubes and the vagina are secondary organs, the former to convey the spermatozoa to the ovum and carry the fertilized egg to the uterus; the latter to receive and pass on the seminal fluid, and to afford a passage for the fœtus to the outer world.

*Reception of the Ovum by the Fallopian Tube.*—In some mammals (bats, *e. g.*) the ovary lies in a closed capsule whose outlet is through a Fallopian tube, but in most, including our own species, this is not the case. The ovary lies quite free in the abdominal cavity, but with the widened fimbriated end of a Fallopian tube close to it. In the human species one of the fimbriæ of the tube (Fig. 1, *6*, p. 69) is attached by a connective-tissue thread to the ovary, and all the fimbriæ are on their inner side covered with ciliated epithelium, which lashes so as to set up a current toward the tube and, through it, to the uterus. The steady flow of peritoneal liquid set up by these cilia in the great majority of cases involves the discharged ovum in its stream, and carries it to the Fallopian tube along the line of the permanently attached fimbria.

The importance of ciliary movements in guiding the ovum to the oviduct is well seen in frogs. In female frogs the lining cells of the peritoneum become ciliated along certain tracts at the time when the eggs are nearly ripe. The ripe eggs are discharged from the ovary into the abdominal cavity, but are gradually carried by the ciliary current to the mouth of the oviduct. After the eggs have been discharged the endothelium of the peritoneum loses its cilia until the next breeding season.

Embryological study, which shows that the oviduct in mammals is but the Müllerian duct of the embryo (p. 191), makes it clear from a morphological standpoint why the oviduct or Fallopian tube is not directly continuous with the ovary. Its discontinuity, however, gives rise occasionally to extra-uterine pregnancies, and in so far the mechanism is physiologically defective. That there is some advantage to our race in the discontinuity of the ovarian gland and its duct, which more than balances the disadvantages, is not likely to be doubted, but what the advantage is no one has hitherto been able to discover. It may be suggested that this discontinuity is but a mere inheritance from ancestral forms (*e. g.* the Annelida), which evolution in its steady working for the benefit of the species has not yet overcome; but to such an opinion stands opposed the fact that even low down in the animal kingdom (Rotifera) we know of genera in which the oviduct is not directly continuous with the ovary, and of other genera or classes in which the oviduct is directly continuous with a hollow ovary, and has the same relationship to it as a salivary duct to a salivary gland (clam, lobster, insects).

## II. MENSTRUATION.

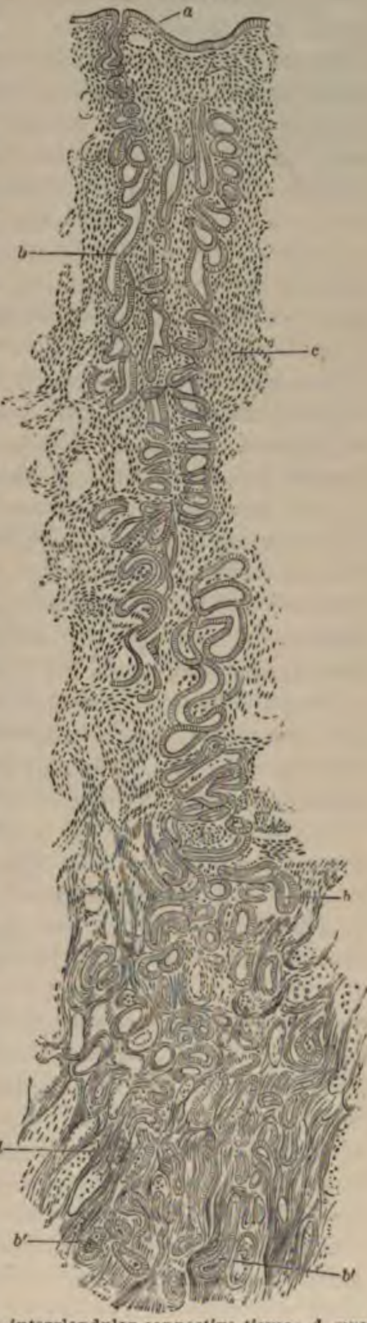
MENSTRUATION.—In the great majority of healthy women great changes in the uterine mucous membrane recur periodically from puberty until the capacity for childbearing has been lost with advancing years. These changes take place at intervals of about four weeks in most cases, and result in a breaking down and discharge of much of the uterine mucous membrane, together with some blood. This discharge is known as the *menses*, or *menstrual flow*, or the *catamenia*. It is associated with considerable changes in the general nutritive processes of the woman: her urea excretion through the kidneys is diminished; her temperature is raised about 0.5° C. Feelings of discomfort or weariness (*molimina menstrualia*) are very frequently present at or just before occurrence of the monthly flow, but may be entirely absent.

*The Histological Changes of the Uterus during Menstruation.*—The mucous membrane of the *cervix uteri* differs in structure from that lining the body and fundus of the organ, and takes no part in the menstrual process. The following statements do not apply to it:

The uterus over most of its outer surface has a *serous coat* derived from the peritoneum: beneath this comes a *muscular coat* of unstriped muscle-tissue, containing also connective tissue, blood-vessels, and nerves; internal to the muscular coat, and closely applied to it, comes the mucous membrane. The outer layer of this membrane is remarkable for the great thickness of its muscular stratum, the *muscularis mucosæ*. This layer of non-striated muscular tissue is found on the deeper side of most if not all mucous membranes, but in most organs is very thin. In the uterus it is very thick, and constitutes the greater part of the thickness of the walls of the virgin organ.

The middle stratum or *corium* of the uterine mucous membrane of the virgin is about one millimeter ($\frac{1}{25}$ inch) thick, and presents a smooth surface except during menstruation. Its basis is a loose vascular connective tissue containing few fibres, but much structureless interfibrillar substance, and having scattered through it very numerous round, fusiform, or irregularly-shaped granular nucleated cells. The inner surface of this corium is lined by a single layer of columnar ciliated cells, and is dotted all over by mouths of tubular glands. These glands traverse the corium as narrow, unbranched cylindrical tubes until they reach the

FIG. 11.



Section of Mucous Membrane of the Uterus near the Fundus (from Ewart after Williams): *a*, epithelium lining the uterus; *b*, *b*, uterine glands; *c*, interglandular connective tissue; *d*, *muscularis mucosæ*, with the deeper ends, *b′*, of the uterine glands, imbedded in it (from Quain's *Anatomy*) specimen prepared from uterus of a young woman who was accidentally killed three or four days before the expected menstrual flow.

*muscularis mucosæ*, in which their deep ends are imbedded and within which they sometimes branch. They are lined by ciliated epithelium continuous with and resembling that on the inner surface of the womb. Their secretion is colorless, sticky, and alkaline. The movement of the cilia of the lining epithelium of the uterus is such that liquids within it are driven toward the *os* and from the *fundus*.

Shortly before the occurrence of the menstrual flow the corium of the uterine mucous membrane grows very fast. It becomes five or six times its usual thickness; its lymph-channels widen, its glands become longer and wider, and it forms a thick cushion filling up the cavity of the body of the womb. Next, the blood-vessels of the membrane become gorged, and either some of them burst and extravasation occurs, or many red corpuscles bore their way (diapedesis) through the walls of the capillaries. Whether the process is extravasation or diapedesis is not yet certainly known, but the former is more probable. Once outside the vessels, some of the blood reaches the uterine cavity, and the rest lies among the tissues of the corium for a time. The amount of blood discharged at a menstrual period varies much even among healthy women. The normal amount is probably somewhere between 100 and 200 grams (5–10 ounces). The discharged blood is mingled with detritus and secretion from the mucous membrane, and before reaching the external opening of the vagina the mixture has usually undergone some decomposition, giving it an unpleasant odor. Hence, probably, the old notion that the menstrual blood was a purification of the woman, removing from her body noxious substances. Perfectly fresh menstrual blood taken from the uterus exhibits no abnormality and clots like ordinary blood. In its passage through the cervix and vagina it usually is mixed with so large a proportion of the secretions of those parts that it will not afterward clot.

After the blood has been passed out, the tissues of the thickened mucous membrane break down. The epithelium cells, the cells lining the necks of the glands, and the connective-tissue corpuscles of the corium, all undergo a sort of fatty degeneration. Usually they fall to pieces completely, and are discharged as a structureless detritus in the secretions of the last days of the menstrual flux, which, instead of being bloody, becomes brown or often nearly colorless. Sometimes, however, coherent patches of the lining cells of the uterus are discharged, or even its whole epithelium in one piece.

During this later stage of menstruation the uterine mucous membrane rapidly decreases in thickness and regains its normal intermenstrual character, the new epithelium to line the uterine cavity starting from the cells of the deeper parts of the glands which were not destroyed during menstruation. Each gland forms a focus from which new epithelium spreads, as each bit of skin transplanted by the surgeon to the surface of a large cutaneous ulcer forms a focus from which new epidermis develops.

After nine or ten days from the onset of menstruation the new uterine mucous membrane is completely formed, and it remains in a passive state for about eighteen days, until the commencement of the next menstrual epoch. After the first menstruation the corium of the mucous membrane never returns to its original thickness of about one millimeter ($\frac{1}{25}$ inch). It is henceforth at least twice as thick.

*The Duration of the Menstrual Flow* varies very much in healthy women. It may last only three days or extend to seven. The Mosaic ritual prescribed seven days as the time of the "impurity" of women.

*The Periodicity of the Menstrual Flow* is also very variable, but twenty-eight days is usually regarded as the normal period, though many healthy women menstruate regularly at intervals longer or shorter than this. More women menstruate during the first quarter of the moon than during any other quarter.

*The Average Age at which the First Menstruation Occurs* has been the object of many statistical researches. It is influenced by race, climate, mode of life, and other conditions, so that great differences prevail between the results of different authors. In temperate climates and the Anglo-Saxon and Teutonic races the first menstruation occurs oftener in the fifteenth than in any other year, but the preponderance of this year over the fourteenth and sixteenth is very slight.

Krieger[1] collected and collated 6550 cases in Germany. 1.59 per cent. menstruated first between the ninth and twelfth years; 9.236 per cent. in the thirteenth; 18.213 per cent. in the fourteenth; 18.931 per cent. in the fifteenth; 15.664 per cent. in the sixteenth; 11.572 per cent. in the seventeenth; 8.885 per cent. in the eighteenth; 6.488 per cent. in the nineteenth; 4.29 per cent. in the twentieth; 1.694 per cent. in the twenty-first; between the twenty-first and thirty-first years, 1.43 per cent.

It seems also to be well established that, other things being equal, city-bred girls menstruate from six to twelve months sooner than those reared in the country. This is probably due to the more stimulating social life of the city and the more frequent association with males for purposes of recreation. Something similar occurs in cattle; two-year-old heifers kept in a pasture rarely go into heat, but it is well known to cattlemen that if let run loose on the ranges they frequently take the bull and become pregnant when they are two-year-olds: as the cowboy puts it, the bulls "tease" them, and the result is an earlier sexual maturity.

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[1] E. Krieger: *Die Menstruation, eine Gynäkologische Studie*, Berlin, 1869 (quoted by Hensen, *Hermann's Handbuch*, vol. vi. part ii. p. 65).

As to climate, most observers agree that the onset of menstruation is earlier in hot than in temperate regions, and in temperate than in cold.

The influence of race under similar climatic influences and conditions of life may be illustrated by the observations of Joachim[1] in Hungary: he found the average age of Slav girls at the first menstruation was sixteen to seventeen years; of Magyars, fifteen to sixteen; of Jewesses, thirteen to fourteen. Tilt's observations may also be quoted in this connection: he found that Hindoo women in Calcutta usually menstruated before the twelfth year (average, eleven years and eleven months), while among the negroes in Jamaica (where the temperature is about the same) the average age at the first menstruation is nearly fifteen years (fourteen years ten months).

When we take into account the variety of races, the great differences in climate, and vast intervals between the extremes of city and rural life which exist in the United States, it is clear that no special age can be stated as the most normal for the onset of the menses in American women. It usually occurs some time between the beginning of the fourteenth and the end of the sixteenth year.

*General Bodily Changes associated with the First Menstruation.*—The occurrence of menstruation indicates that *puberty* has been reached—that the girl has become a woman and capable of becoming a mother: it is associated with or somewhat preceded by other phenomena both material and mental. The womb and vagina enlarge; the external labia increase in size and more completely cover the underlying parts; scattered hairs develop on them and also on the *mons Veneris*, which becomes more prominent. The breasts swell and the nipples project. The pelvis enlarges, and the buttocks and thighs develop more subcutaneous fat and become larger and more rounded; and there is in many cases an increased accumulation of fat beneath the skin of most of the body, making all its contours more rounded and graceful. The mental changes are manifested by the occurrence of sexual desires and many secondary phenomena which proceed from them.

*The Cessation of Menstruation* is as indeterminate as its onset. It usually takes place between the forty-fifth and the fiftieth year. This cessation (climacteric) is sometimes succeeded, especially in unmarried women, by a loss of feminine anatomical traits and the assumption of some of the bodily characteristics of the man. The form in such cases becomes more angular, the voice harsher, and an imperfect moustache or beard may develop.

*During Pregnancy and Lactation the Menstrual Flow usually Ceases*, but as regards lactation often for some nine or ten months only. According-ing to Hogg,[1] about 1 per cent. of pregnant women continue to menstruate until they are four or five months with child. But pathological bleedings are often distinguishable with difficulty from menstrual flows, and probably in many of these cases were not distinguished from them. Hogg's tables also tend to show that 0.14 per cent. of pregnant women menstruate until the time of parturition, but here again we probably should make allowance for blood-flows which were not true menstruations. Cases are, however, not infrequent in which a single imperfect menstrual flux takes place at the period next following conception.

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[1] *Schmidt's Jahrb.*, lxxxiii. p. 56 (quoted by Hensen in *Hermann's Handbuch*).

*The Physiological Significance of Menstruation.*[2]—Why menstruation should occur in women during the childbearing age, and what the use of it is, are questions which must have forced themselves on mankind ever since our race began to think about the why or the wherefore of anything.

The most prominent fact in connection with the catamenia being the bloody discharge, this at first was the thing chiefly regarded, and the physiologists and physicians of olden times strove to account for the phenomenon by giving a reason for the discharge of this blood. One theory was that the healthy body might come to contain too much blood, and that the discharge of some of it was essential to health. Aristotle and, from his time down to and including Haller, many naturalists held this opinion, and explained menstruation as a process necessary to get rid of the excess of blood which had collected in the body of the woman, either locally or generally. This "plethora" doctrine in a wider form extended even into comparatively recent times, and led to the annual spring bloodletting to which our grandfathers and grandmothers subjected themselves.

Another opinion, even older than that of the Greeks, was that of the Jews, indicated in the Mosaic ritual, that impure matters collected in the woman's blood and were discharged in the menstrual flux, which was therefore a purification. The arch-charlatan Paracelsus and the honored physiologist and embryologist De Graaf held this doctrine. Our present knowledge shows that the blood-flow is a secondary, and not the primary fact in menstruation, but there may be some truth in a modification of the "purification" theory. One important function of the mucous secretion of the alimentary canal appears to be that the mucus entangles and carries on with it to the rectum indigestible and other possibly harmful solid particles, as microbes. The uterus not merely cleanses itself by secretion and expulsion of mucus, which might sweep and cleanse its lining membrane, but discharges during menstruation all the superficial parts of that membrane. We know

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[1] *Med. Times and Gazette*, 1871.

[2] For a fuller discussion of this question, see Hensen in *Hermann's Handbuch*. Much of the following three or four pages is translated from him, with but slight change.

that lying-in women are especially apt to be infected by pathogenic bacterial organisms; and in the earlier stages of its evolution, when the egg is still segmenting and the decidua reflexa forming, it may well be that the young embryo might be easily infected by extraneous organisms. This view gives us one logical meaning for menstruation. It gives us a reason for that entire casting off of the surface-layers of the mucous lining of the womb which occurs each month. Menstruation breaks down and discharges all the old mucous membrane, and gets rid of bacteria which may have entered through the *os* and found in the womb a suitable nidus for development. Hence in a modified form the purification doctrine is still tenable as giving a physiological reason for menstruation.

Another theory, still held by some, is that menstruation represents a "missed" conception—that the uterus, having been all prepared to nourish an embryo, got rid of this accumulated excess material in the menses when conception did not occur at the time of ovulation. An exactly contrary view has been put forward by Naegele[1] (1812)—namely, that menstruation renews a capacity for conception which had been gradually lost by the uterus in the intermenstrual period—that menstruation was a rhythmical renewal of the embryo-nourishing power of the uterus.

In order to get some clear idea as to what is the real physiological significance of the menstrual flow, we must consider it in connection with that epoch of special sexual appetite in animals known as *heat* or *rut*, and with the process of ovulation.

*The Relationship of Menstruation to the "Heat" of the Lower Animals.*—When he says that a female mammal is "in heat" the breeder of cattle and other domesticated animals means that the external generative organs are congested and the female is in a special mental condition which leads her to yield to or to seek the solicitations of the male, which at other times she opposes. In animals which normally breed but once a year (horses, cattle, sheep, deer, etc.) the period of heat occurs in each year at a definite time correlated with the length of pregnancy, so that the young shall be born at a season when food for them and for their mother shall be most abundant. Natural selection, working through heredity, would of course soon establish this relationship. Offspring born at inopportune seasons, when food was scarce, would have less chance of surviving than the offspring of parents born at a more favorable time of the year, and the survivors would, when they became adult, tend to go into heat and to bring forth their young at the same seasons as their parents.

The human race for so many hundreds of generations has been able to provide itself with food and fire at all times of the year that the influence of the seasons in determining a special epoch of sexual appetite might well have been eliminated, even if we assume that it once existed. That it did once exist, and that some remnant of it remains, seem to be indicated by the popular association of spring with the courting of lovers. Tennyson but echoes the general belief when he writes—

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[1] *Erfahrungen und Abhandlungen*, Mannheim, 1812.

> "In the spring the young man's fancy lightly turns to thoughts of love;"

and what is true of the young man is probably true of the young woman. To pass from poets to statisticians, it is found that rather more births occur in the winter than in other months, which tends to indicate some slight excess of sexual appetite or sexual capacity in the spring of the year.

In further considering the relationship of menstruation to "heat" we must bear in mind that unrestrained females of the lower animals almost invariably become impregnated during the period of heat, while the social conditions which prevail in human societies frequently prevent this. Hence it becomes important to inquire what happens in the case of cows, mares, and other animals if copulation does not occur during the period of "heat." If in such cases it is found that the period of sexual exaltation passes off in the female for a time, but recurs after a certain period, it becomes more probable that the periodic recurrence in non-pregnant women of the processes leading to menstruation may be fundamentally the same as those which lead to "heat" in other female mammals.

It has been ascertained by breeders that if the ram be kept from a ewe during her "heat," the sexual appetite and the congestion of the external genitals pass off, but only to recur in about fourteen days; and if sexual congress be then prevented, the ewe is again in heat after a fortnight; and so on. Similar phenomena have been observed in sows, cows, mares, and apes, though the intervals between the periods of heat vary in different animals. At each of these recurring *heat* periods the female is capable of conceiving if sexual congress takes place; hence ovulation is in these animals associated with *heat.*

A special secretion from the uterine mucous membrane of many animals has long been known to occur periodically, and is often combined with slight extravasations of blood on the surface of the membrane (bitch, cow, some bats). In certain apes there is a well-marked bloody discharge at intervals of four weeks. These secretions or discharges are connected with ovulation, which seems to occur mainly toward the end of their period. Buffon found that the bitch would only take the dog six or seven days after the commencement of the period of special uterine activity, and according to Bischoff the egg is discharged normally toward the end of a menstrual flow.

As regards the mammals below man, it may, then, be assumed as well established that uterine activity, resulting in a more or less complete menstruation, is a periodic phenomenon closely associated in time with ovulation; the menstrual processes appearing, however, to rather precede the ovulation.

In most instances, also, ovulation accompanies or immediately precedes heat, but there are well-marked exceptions; in bats, for example, the epoch of heat and copulation precedes by months the processes of ovulation and fertilization. It would therefore appear that ovulation is not necessarily associated with heat or with the uterine changes representing menstruation.

As regards woman, it seems generally admitted that a period of special sexual desire is apt to immediately follow menstruation (Haller, Bischoff, Litzmann). It is also generally believed that while an ovum may be discharged at any time during the years from puberty to the climacteric, yet that normally ovulation is a periodic process having the same rhythm as the menstrual; and this belief seems to be well founded. Whether in each month ovulation precedes menstruation in time, or coincides with or follows it, is still in dispute. We shall later give reasons which make it probable that ovulation occurs usually at or just after the cessation of the menses.

The generally-recognized fact that ovulation and menstruation in woman are rhythmic processes recurring at the same intervals, and more or less closely contemporaneous, has led to a widely-accepted belief that one process depends on or is initiated by the other. It has been assumed either that menstruation reflexly excites the ovaries, or that the ovarian changes resulting in the swelling and bursting of a Graafian follicle irritate ovarian nerves and reflexly excite menstrual changes in the womb. But a third view is possible—namely, that the processes are essentially independent, though they have become in the course of evolution closely associated; and this view seems to the writer the most tenable. It is easy to see how this association might, or indeed must, have originated in time through the process of natural selection.

Assuming for the present, what probably no one doubts, that the uterine changes so conspicuous in the woman as menstruation are in some way connected with the preparation of the womb for the nutrition of the developing embryo (see p. 132), it is clear that the periodicity must give female mammals, who only went through this more or less exhausting process at times when ova were ready for discharge and fertilization, an advantage in leaving descendants. They would have more chance of surviving and of leaving offspring. They would win in the struggle for existence of their race. We have seen also that the changes in the vulva leading to "heat" in the female mammal are in the higher mammals closely associated in time, and probably in causation, with the uterine changes which result in a more or less complete menstrual process. But a continuous sexual heat leading the female mammal to accept or invite the male at all times, even when no ova were ready for fertilization, must be prejudicial to the continuance of the race by leading to a waste of the male reproductive powers.

There would, therefore, be a double advantage in the struggle for existence to any race the females of which were only in heat at times coinciding with the epochs of ovulation, which latter, as we have already seen, is a periodic process. Natural selection must therefore, in the case of the higher animals, almost inevitably bring it about that ovulation and uterine preparation should in the process of evolution come to be closely associated in time even were they, in ancestral forms, quite independent processes.

This close association, continued for generations and always favored by natural selection, would undoubtedly in time lead to secondary connections between the two phenomena, were they originally quite distinct. Ovarian and uterine changes, occurring generation after generation at the same time, would act on the whole physiological working of the organism, and modify it so that when one occurred the other was apt to happen. The ripening of an egg or eggs within the ovary being the primary and essential phenomenon to which preparation of the uterus for its nourishment is secondary, and without which it is not merely useless, but wasteful, it seems obvious that once a causal connection has become established between the two processes, the maturation of the ovum will take the lead; uterine changes will come to depend on it, and not it on uterine changes.

Menstruation, as already pointed out, is a phenomenon strictly comparable to changes which occur in the wombs of many other mammals, though it is only in some of the higher apes and in our own race that it is indicated externally by a conspicuous bloody discharge. Therefore, if the reasoning in the preceding paragraphs be correct, menstruation (=changes in womb fitting it to nourish a fertilized egg) might be expected to be closely associated with ovulation, and in a great majority of cases dependent on it, and excited by the ovarian changes (such as tension) brought about by the swelling and ripening of a Graafian follicle. In other words, preparation with nothing to prepare for would be a sheer waste of energy; and natural selection, working through heredity, has brought it about that menstruation, though primarily quite independent of ovarian changes, has come to be, in the vast majority of cases, determined by them.

That ovulation may and does occur apart from menstruation seems proved by such cases as that of Oldham.[1] In this instance the ovaries had descended into the labia majora, and every three or four weeks one or both swelled and became tender; the uterus and vagina were absent.

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[1] *Proc. Roy. Soc.*, viii. p. 377.

If we accept this view (that there is a secondary acquired, but not primary or necessary, connection between ovulation and menstruation) many puzzling facts are easily explained. There is no doubt that in the human race removal of the ovaries in a great majority of cases leads to cessation of menstruation: that the experience of physicians has led them to a very general acceptance of this belief is evidenced by the considerable number of cases in which the serious operation of oöphorectomy has been performed for the cure of otherwise uncontrollable and dangerous menorrhagia: the correctness of the belief which led to the operation is evidenced by the large number of cures resulting from it. Moreover, the instances in which removal of the ovaries has led to cessation of normal menstruation are so numerous that Hensen[1] says that "no one now takes the trouble to record the cases."

On the other hand, it is well established that women who have never menstruated have borne children: they must have ovulated without menstruating. If, however, we realize that changes in the uterine mucous membrane fitting it to nourish an embryo may take place without any noticeable discharge from the vagina (as in many mammals), there is no difficulty in accounting for such exceptional cases.

Again, Lawson Tait and others have published cases in which menstruation has continued after removal of the ovaries. In some such instances it is probable that the bloody discharge from the uterus was not really menstrual, and in others that the ovaries were not entirely removed. But, making all due allowance for mistakes, it seems indubitable that in a small percentage of women true menstruation continues after complete oöphorectomy. This is just what might be expected if uterine activity be only secondarily associated with ovarian activity. In a certain number of patients menstruation would still manifest its essential independence and the uterus go through the menstrual changes independently of excitation from the ovaries.

*The Physiologically-acquired Connection between Ovulation and Menstruation* could be easily explained by supposing that a distended Graafian follicle irritated afferent ovarian nerve-fibres, and that these, acting through the spinal cord as a centre, set in action trophic and vasodilator nerves going to the womb. But it is quite possible that the association may not be nervous—that it may be due to chemical changes in the circulating liquids of the body brought about by ovarian activity. Goltz[2] has shown that after complete section of the dorsal spinal cord of a bitch, not merely the external symptoms of heat (*e. g.* swelling of the vulvar organs), but also the normal psychical concomitants of ovulation, are present, and that when a bitch with a cut spinal cord becomes pregnant the mammary glands develop in the normal manner. To quote from Foster—[1]

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[1] *Hermann's Handbuch*, vol. vi. part 2, p. 71.

[2] *Pflüg. Arch.*, vol. ix. p. 552.

"In the case of a bitch observed by Goltz 'heat' or menstruation took place as usual, though the spinal cord had been completely divided in the dorsal region while the animal was as yet a mere puppy.

"The operation was performed in Dec., 1873. In the following May the animal was in excellent health. . . . . At the end of that month 'heat' came on, attended by all the ordinary phenomena, psychical as well as physical. Impregnation was effected and the animal became gravid. The pregnancy, like the heat, was marked by all the usual signs: the mammary glands enlarged, and the usual mental accompaniments of the condition were present. Finally, one living and two dead puppies were born. . . . . The post-mortem examination showed that there had been no regeneration of the divided spinal cord; the two portions were separated by more than a centimeter.

"In this case the connection between the ovary on the one hand and the mammary gland, brain, etc. on the other, must, if a nervous one, have been furnished by the abdominal sympathetic. We may, however, suppose that the nexus was a chemical one—that the condition of the ovary and uterus effected a change in the blood, which in turn excited the mammary gland to increased action and produced special changes in the brain."

That ovarian changes may profoundly influence almost every organ in the body has long been recognized by physicians, but it has usually been assumed that the influence was excited through the cerebro-spinal nerve-centre. The above-described experiment shows that this is by no means necessarily the case. So far as the local phenomena of "heat" and menstruation are concerned, we must still regard it as an open question whether the ovary influences the womb and external genitals reflexly through the spinal cord or through some other channel. The probability is, however, that the uterine and vulvar changes are spinal reflexes.

*The Time Relationships of Ovulation and Menstruation.*—That the ripening and swelling of a Graafian follicle normally precede menstruation is hardly open to doubt; but the question whether the follicle bursts and discharges its ovum just before or shortly after menstruation, has been much discussed and perhaps cannot yet be conclusively answered.

In women whose ovaries have taken the normal path of the testes and descended into the *labia majora*, it has been observed that they swell and become tender at periods of about four weeks. In Oldham's case[2] the swelling increased for four days; then the size of the organ remained stationary for three days before it commenced to return to its usual bulk. In this patient, however, uterus and vagina were absent; so it gives no clue to the time relationships of menstruation and ovulation. In another published case (Verdier) only the right ovary had descended into the labium and the uterus and vagina were present. The ovary swelled before the onset of the menses, and diminished just after they had ceased. So far as one may draw conclusions from a single instance, it would seem, from this case, that ovarian swelling (due to distension of a Graafian follicle) precedes menstruation, and that ovarian shrinking (due to bursting of the follicle and discharge of the egg) immediately follows it.

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[1] *Textbook of Physiology*, 3d ed., p. 552.

[2] *Proc. Roy. Soc.*, viii. 377; see also Farre: *Todd's Cyclop.*

Post-mortem examinations of women who have died during or soon after menstruation have rarely been made with proper care, and very few cases are recorded in which an unfertilized egg was properly sought for. Hyrtl[1] records the case of a woman who had menstruated three days before her death, and in whom an ovum was found near the uterine end of a Fallopian tube. Bischoff[2] from 13 cases, in some of which the Graafian follicle was found burst during menstruation, concludes that the time relationships of ovulation and menstruation are subject to considerable variation. Coste found in some cases the egg discharged one day after menstruation, and in others that it was still in the follicle five days after the onset of the menstrual flow.

That ovulation is normally in the human race at present associated with menstruation seems certain, for reasons already stated; also that menstrual changes in its mucous membrane prepare the uterus to receive and nourish the egg. The difference of opinion is whether the uterus is best prepared to nourish the egg when the decidua is developing or after it has been discharged? In other words: Before the menstrual flow has commenced or just after it has ceased?

*The Doctrine of His, Reichert, and others* is, that the swollen, soft, vascular uterine mucous membrane just before the menstrual discharge commences, is in the best condition for the nourishment of the ovum: therefore ovulation normally occurs before the menstrual flux. If the egg be not fertilized, the mucous membrane disintegrates and is discharged with the menses.

*The Doctrine of Pflüger* is, that the menstrual uterine changes have the purpose and result of providing a clean or raw surface on which the fertilized ovum may settle and be nourished—that the whole object of menstruation is comparable to that of the surgeon when he pares two surfaces before he brings them in contact with the intention of getting them to grow together. In accordance with this view, menstruation should normally precede ovulation, or at least be completed before the ovum has traversed the Fallopian tube and reached the uterus.

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[1] *Zeitschrift f. rat. Med.*, New Series, vol. iv. p. 129.

[2] *Loc. cit.*

The majority of post-mortems on menstruating women accord better with Pflüger's theory, as also do the facts observed (p. 89) on lower animals. It is also in agreement with the usually adopted method of reckoning parturition as due forty weeks from the last menstruation—a method which gives correct results in the great majority of cases.

The strongest arguments in favor of the contrary view are based on the slight development of a number of embryos found (either post-mortem or in cases of abortion) ten days or a fortnight after the first missed menstruation. It is argued that the development of the embryo has so little progressed that it cannot be five or six weeks' old, which it must be if it dated from the end of the last observed menstrual flow, and that therefore conception must have just preceded the expected but missed menstrual flow, and have prevented it. Such arguments are, however, of but little value, as we know that the rate of development of the embryo in its early stages varies greatly in different mammals, and we have at present no data sufficient to enable us to state at what rate the human embryo grows and develops in the first month of its existence.

Arguments based on the duration of pregnancy from a coitus known to have been fruitful to the date of parturition have their value greatly diminished in consequence of the fact that spermatozoa may remain alive and functional for some days within the Fallopian tubes. The older method of reckoning from the first day of the last menstruation gives about two hundred and eighty days as the mean duration of pregnancy. If, however, conception usually occurs after menstruation, the period of pregnancy must be shorter. Loewenhardt has collected records of 518 cases in which the women could state the date of the coition, and finds, on analyzing them, that the average duration of pregnancy is 272.2 days. Loewenhardt collected 67 cases from the marriage-and-birth register of a church. He found the average duration of pregnancy in cases in which a child was born within ten months from the marriage night to be 272.5 days, but that in a considerable number of cases the births were twenty-one days later; these were probably due to conceptions just before the first menstrual period occurring after wedlock, and not just after the menstrual period which preceded it.

Hasler[1] finds, from the comparison of a large number of cases in which the date of coition could be determined, that the mean duration of pregnancy is 280.5 days from the onset of the last menstruation, but 272.24 days from the date of coition. The following curves, [illegible] are based upon 248 cases in which the date of copulation and of menstruation was known:

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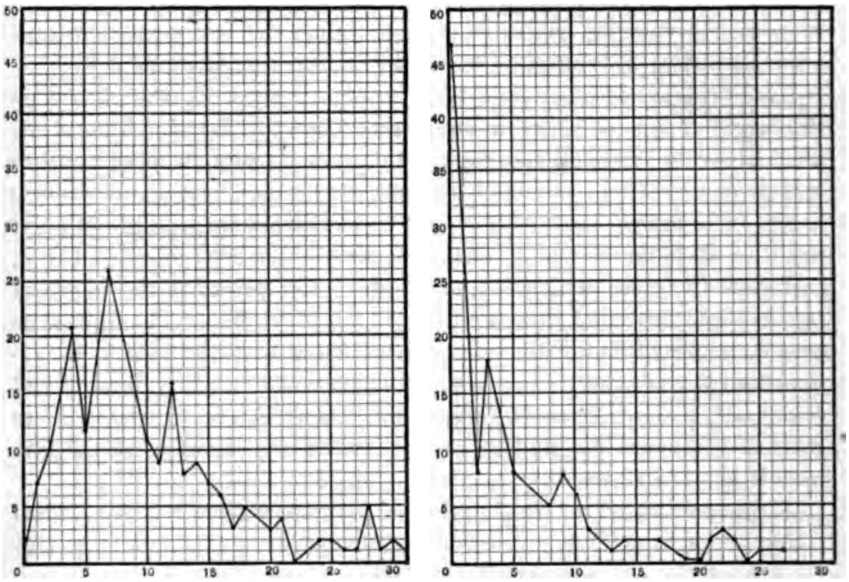
[1] *Ueber die Dauer der Schwangerschaft*, Zürich, 1876.

The curves show very plainly that the day after the cessation of the menses is by far the most favorable to conception, but they show also that conception may follow coitus at any time in the case of a woman capable of conceiving.

FIG. 12.



Curves showing Relative Frequency of Conception following Coitus at Different Times in relation to Menstruation. In both diagrams the divisions on the abscissa line correspond to days: in the first, to days after the onset of menstruation; in the second, to days after the cessation of menstruation. The curves indicate the proportion of conceptions to copulations on each day of the menstrual month.

*Summary.*—We may sum up the facts stated in the present section in a few general statements:

1. Menstruation and ovulation are in the human female closely associated, but are not necessarily mutually dependent processes.

2. In the great majority of cases in the human race ovulation follows menstruation, but the ovarian changes preceding ovulation and producing tension of the ovary reflexly excite the uterus and induce menstruation; and this is completed or nearly completed before the ripe distended Graafian follicle bursts.

3. Ovulation may occur without menstruation, and menstruation without ovulation, but in women this is exceptional.

4. Conception is more apt to result from a coitus immediately after the cessation of the menstrual flow than from sexual connection at any other time.

## III. FERTILIZATION OF THE OVUM.

*Fertilization of the Egg*, which is the primary fact in *conception*, consists essentially in the fusion of a male pronucleus derived from a spermatozoon with the female pronucleus remaining in the egg after extrusion of the polar bodies (p. 78).

*Spermatogenesis.*—The study of the development of the spermatozoa shows that each one is the morphological equivalent of a cell. The *head* of the spermatozoon is a cell-nucleus imbedded in a thin layer of cell-protoplasm; the tail is a *cell-body* specialized to form a motile organ or cilium.

Just as in the ripening of the ovum some of the matter of the mother-cell is separated in the polar globules, so in the development of spermatozoa some of the material of the mother-cell (or *spermatoblast*) is cast off as the *seminal granule* or *accessory corpuscle*. If we accept the view of Minot and Balfour, that the polar globules represent the male element in the primitive egg-cell, which is eliminated in order to make cross-fertilization possible, we may explain the accessary corpuscle of the developing spermatozoon as representing the female element of a primitive reproductive cell, extruded in order that the residue (spermatozoon) may be unable to reproduce by itself, but be fitted to fuse with a ripe ovum and give rise to a new compound cell, the *oosperm*, due to the fusion of living matter from two individuals, and ready to segment and develop into a new animal.

The formation of the accessory globule is not confined to animals: it is very conspicuous in many plants which produce motile *antherozooids* (*e.g.* ferns: see Fig. 253 in Sach's *Textbook of Botany*, English translation, 1875, p. 343).

The development of spermatozoa differs much in detail in various groups of animals: they arise, however, in all cases from primitive generative cells, which are in the embryo apparently quite like the cells of the generative epithelium (p. 195) which give rise to ova in the female sex. The process starts with "germinal cells" which are of no sex: later, in some individuals these give origin to ova, in others to spermatozoa. To quote from Haddon:[1] "The primitive sperm-cells or mother-cells of the spermatozoa arise from a tissue corresponding to that which gives rise to the primitive ova. The exact manner in which the spermatozoa are developed varies in different animals, and has been variously described by numerous investigators. This being the case, it will be advisable to give simply a sketch of what appear to be the most important facts in spermatogenesis.

"Those cells of the generative epithelium [of the embryo, see p. 195] which develop into male sexual cells undergo cell-division in the ordinary manner, and may give rise to a considerable number of *spermatoblasts.* Each spermatoblast gives rise to a spermatozoon, and in doing so gives [off] a small mass of protoplasm, the so-called *seminal granule* or *globule* or *accessory corpuscle,* which appears to have no further function. Fig. 13, A–H, illustrates this process in the rat.

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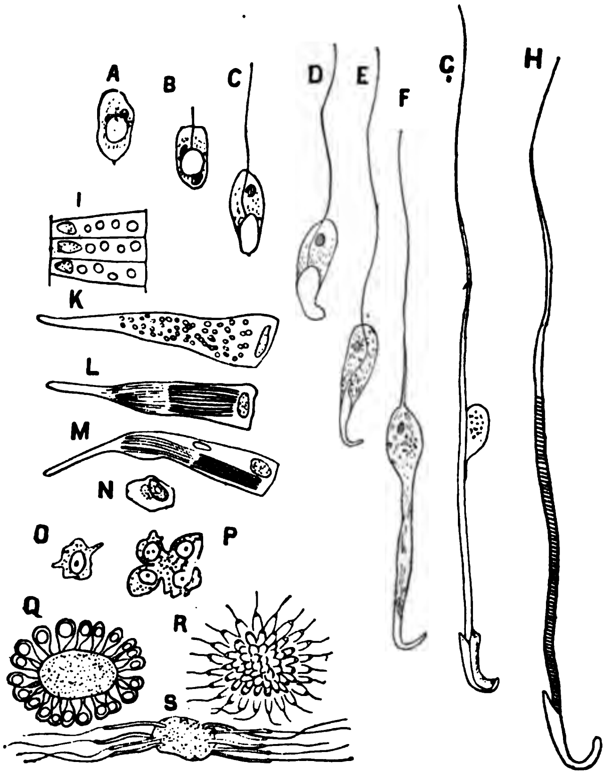
[1] Haddon: *Introduction to the Study of Embryology*, 1887, p. 11.

FIG. 13.



(From Haddon): A-H, Isolated Sperm-cells of the Rat, showing the development of the spermatozoon and the gradual transformation of the nucleus into the spermatozoon head. In G the seminal granule is being cast off (after H. H. Brown).

I-M, Sperm-cells of an Elasmobranch. The nucleus of each cell divides into a large number of daughter-nuclei, each of which becomes converted into the rod-shaped head of a spermatozoon (after Semper).

N, Transverse Section of a Ripe Cell, showing the bundle of spermatozoa and the passive nucleus (I, N, after Semper).

O–S, Spermatogenesis in the Earthworm: O, young sperm-cell; P, the same divided into four; Q, spermatophore with the central sperm-blastophore; R, a later stage; S, nearly mature spermatozoa (after Blomfield).

"Instead of becoming distinct, the spermatoblasts or incipient spermatozoa may remain aggregated together (*spermosphere* or *sperm-morula*) and surround a central non-nucleated protoplasmic mass (the *sperm-blastophore*), as in the case of the snail and earthworm (Fig. 13, O–S).

"In Elasmobranchs [sharks, dog-fishes, rays], Fig. 13, I–N, the nucleus of the sperm-cell alone divides, forming a number of daughter-nuclei, the remains of the parent-nucleus still persisting. The protoplasm of the cell differentiates into the tails of the spermatozoa, while the daughter-nuclei constitute their heads. The ripe spermatozoa are liberated by the rupture of the wall of the sperm-cell, leaving behind the remains of parent-nucleus and a small remnant of unused protoplasm. This is merely an abbreviated variation of the [process in the snail and earthworm]: the residual nucleus and protoplasm clearly correspond to the accessory corpuscle or sperm-blastophore in the preceding forms.

"The nucleus of each daughter sperm-cell constitutes the head of a spermatozoon; it is surrounded by an extremely delicate film, which is produced at one end into a fine flagellum, and sometimes, also, into an almost imperceptible undulating membrane. [The enclosing film, the flagellum, and the membrane] are formed by the [extra-nuclear] protoplasm of the spermatoblast. Every spermatozoon is thus a true morphological cell."

Observations on the lower animals show that normally but one spermatozoon fertilizes an egg. Many may collect around it, and even penetrate its coverings, but only one enters the egg-protoplasm and is efficient in its fertilization.

It is probable that once the spermatozoa have reached the neighborhood of the ovum their movements are controlled by some substance excreted by the egg and diffused in the liquid bathing it. In some of the lower plants (ferns and others) the male elements are motile *antherozooids:* if a capillary tube containing a weak solution of malic acid be immersed in a water containing antherozooids, the latter swim toward the opening of the tube. The malic acid, slowly diffusing through the water, controls the movements of the antherozooids, so that their cilia lash in a manner tending to drive them to the place where there is most malic acid. It has also been found that malic acid is excreted by the female organs of these plants. Some similar process may occur in the higher mammals and lead to a swarming of spermatozoa around the egg.

Barry[1] was the first who described spermatozoa within the zona pellucida of the mammalian ovum. His observations, made on the rabbit, have been confirmed, more than twenty spermatozoa having been seen within the egg-case by Hensen.

According to Hensen's observations on the rabbit, the spermatozoa begin to penetrate the zona pellucida about thirteen hours after coitus. The cells of the discus proligerus have by this time undergone a mucous degeneration, and the vitellus has shrunk somewhat (from the expulsion of liquid), and has given off the polar bodies. Some of the spermatozoa enter the zona obliquely, and these never get through it; others

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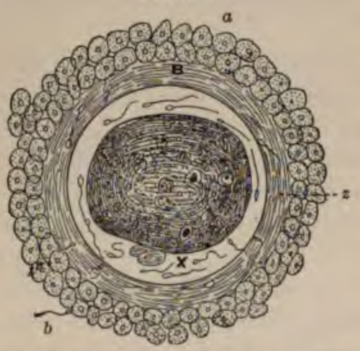
[1] *Phil. Trans. Roy. Soc.*, 1843.

enter it perpendicularly, and bore their way into the space between the contracted ovum and the zona (Fig. 14). One of them enters the egg-protoplasm, and its head or nucleus may for a time be seen as the *male pronucleus;* this approaches the female pronucleus, and the two fuse to form the *segmentation nucleus* of the fertilized egg, which latter is henceforth named the *oosperm*. From this fertilized cell, made up of food-materials stored in the vitellus, of protoplasm of the egg mingled with protoplasm from the tail of the spermatozoon, and of a nucleus resulting from the fusion of the head of the spermatozoon (male pronucleus) with the residue (female pronucleus) of the germinal vesicle of the ovum, the fœtus with all its tissues and organs is developed by cell-multiplication and cell-modification.

Fig. 14.



A Rabbit's Egg being Fertilized (Hensen): *a*, cells of the discus proligerus; *z*, zona pellucida. At *b*, on the lower left-hand part of the figure, a spermatozoon is seen beginning to make its way between the cells of the discus proligerus. Several spermatozoa are seen imbedded in the zona pellucida, the majority of them obliquely placed with reference to a diameter of the ovum. The yelk has contracted and given off the polar globules. Many spermatozoa which have bored their way vertically through the egg membranes are seen in the space between the vitellus and the zona pellucida. At *x* is seen the remnant (*male pronucleus*) of the head of a spermatozoon which has penetrated the vitellus.

*The Origin of Tissues and Organs by Differentiation.* — The fertilized egg divides into a number of cells: these, at first alike, arrange themselves into groups, and, continuing to multiply by division, give rise to cells which grow in many different ways and assume characteristic microscopic forms. Some elongate into fibres, others remain more or less rounded; some excrete around them a large amount of intercellular substance and make cartilage, bone, and connective tissue; others make little intercellular substance. In some the contractility of the original egg-protoplasm is intensified and they become muscle-fibres. Others become so modified in structure that they almost or quite lose the contractile power possessed by the ovum, but develop to a high degree its *irritability*, or faculty of being easily changed by external influences: they become nerve-cells or the end-organs of nerve-fibres in the retina and other sense apparatuses. Some cells become distinctly secretory, others excretory; some become horny, and as epidermis, hairs, and nails serve to protect the organism. The general result is that from a set of similar cells, formed by the division of a single cell, the *oosperm*, there is developed that heterogeneous mass of groups of cells, each with distinctive modes of growth and with special physiological properties, which constitutes the tissues and organs of the adult human body.

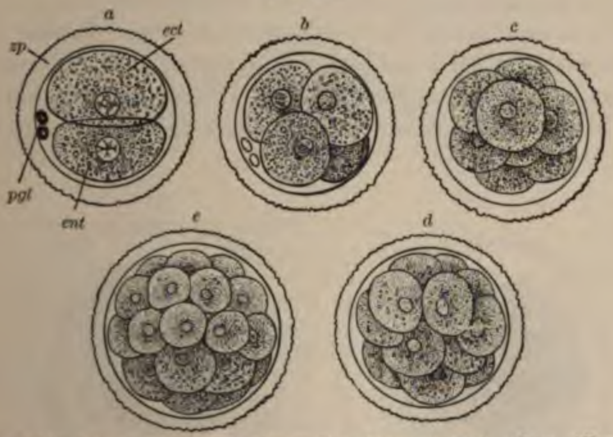
## IV. THE EARLY STAGES OF DEVELOPMENT.

*The Segmentation of the Fertilized Ovum* (*Oosperm*) has not been directly observed in human eggs; it probably does not differ much from the same process in the rabbit, a knowledge of which we chiefly owe to the valuable researches of Ed. van Beneden.[1] We cannot do better than quote the summary of Van Beneden's results as given by Balfour[2] (words in square brackets are interpolated):

The protoplasm of the oosperm "first divides into two nearly equal spheres (*a*, Fig. 15), of which one is slightly larger and more transparent than the other. The larger sphere and its products will be spoken of as the [*epiblastic*] spheres, and the smaller sphere and its products as the [*hypoblastic*] spheres, in accordance with their different destinations." [The cells which result from the division of the ovum, and have not yet been specialized to form particular layers of the embryo are named "blastomeres."]

"Both the spheres are soon divided into two, and each of the four so formed into two again (Fig. 15, *b*), and thus a stage with eight spheres ensues (Fig. 15, *c*). At the moment of their first separation these spheres are spherical and arranged in two layers, one of them

FIG. 15.



First Stages of the Segmentation of a Mammalian Ovum (rabbit) (from Allen Thomson, after Ed. v. Beneden's description): *zp*, zona pellucida; *pgl*, polar globules; *ect*, first epiblast cell; *ent*, first hypoblast cell; *b*, stage of four blastomeres; *c*, eight blastomeres, the *epiblast* cells partially enclosing the *hypoblast* cells; *d*, and *e*, later stages of segmentation, showing the more rapid multiplication of epiblast cells and the gradual surrounding by them of the hypoblast cells.

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[1] "Développement embryonnaire des Mammifères," *Bull. de l'Acad. Belgique*, 1874; "La Maturation de l'Œuf, la Fécondation et les premières Phases du Developpement embryonnaire des Mammifères," 1875; "Recherches sur l'Embryologie des Mammifères," *Archives de Biologie*, 1880.

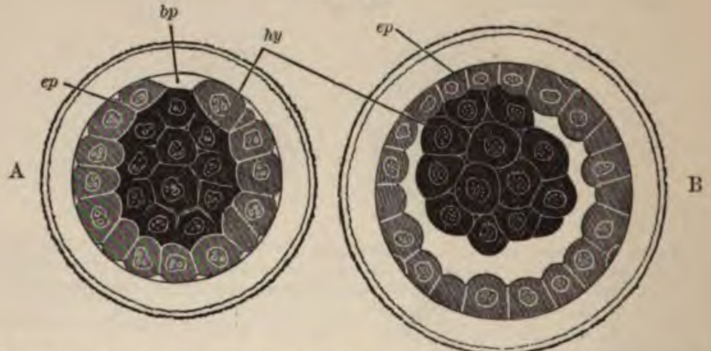
[2] *Elements of Embryology*, by Foster and Balfour, 2d ed., 1883, p. 313.

formed of the four epiblastic spheres and the other of the four hypoblastic. [The embryo is therefore at this time somewhat flattened.] This position is not long retained, but one of the hypoblastic spheres passes to the centre, and the whole ovum again takes a spherical form.

"In the next phase of segmentation each of the four epiblastic spheres divides into two, and the embryo thus becomes constituted of twelve spheres, eight epiblastic and four hypoblastic. The epiblastic spheres have now become markedly smaller than the hypoblastic (Fig. 15, *d*).

"The four hypoblastic spheres next divide, giving rise, together with the eight epiblastic spheres, to sixteen cells in all, which are nearly uniform in size. Of the eight [hypoblastic] spheres, four soon pass to the centre, while the eight superficial [epiblastic] spheres form a kind of cup partially enclosing the [hypoblastic] spheres (Fig. 15, *e*). The [epiblastic] spheres now divide in their turn, giving rise to sixteen spheres, which largely enclose the [hypoblastic] spheres. The segmentation of both [epiblastic and hypoblastic cells] continues; in the course of it the epiblastic spheres spread farther and farther over the hypoblast, so that at the close of segmentation the hypoblast spheres constitute a central solid mass almost entirely surrounded by the epiblast spheres. In a small circular area, however, the hypoblast spheres remain for some time exposed on the surface (Fig. 16, A, *bp*).

FIG. 16.



Optical Sections of an Oosperm of a Rabbit, at two stages closely following upon segmentation (from Balfour, after Ed. v. Beneden): *ep*, epiblast; *hy*, primary hypoblast; *bp*, the opening in the epiblastic layer at one point, named blastopore by E. van Beneden: this is not a true blastopore. The shading of the epiblast and hypoblast is diagrammatic.

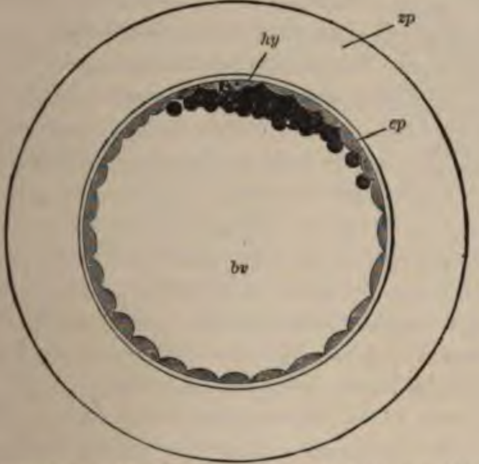
"The whole process of segmentation is completed in the rabbit about seventy hours after impregnation. At its close the *epiblast cells*, as they may now be called, are clear and have an irregularly cubical form, while the *hypoblast cells* are polygonal and granular, and somewhat larger than the epiblast cells."

[The developing oosperm at the close of segmentation is named the *morula* or mulberry mass.]

"After its segmentation the [oosperm] passes into the uterus. The epiblast cells soon grow over the blastopore [of Van Beneden, which is merely an uncovered part of the hypoblast], (*bp*, Fig. 16, A), and thus form a complete superficial layer.

"The succeeding changes commence with the appearance of a narrow cavity between the epiblast and hypoblast, which extends so as to completely separate these two layers, except in the region adjoining the original site of the [uncovered portion of the hypoblast], (Fig. 16, B). The cavity so formed rapidly enlarges, and with it the ovum also, which soon takes the form of a thin-walled vesicle with a large central cavity. This vesicle is the *blastodermic vesicle.* The greater part of its walls is formed of a single row of flattened epiblast cells, while the hypoblast cells form a small lens-shaped mass attached to the inner side of the epiblast cells (Fig. 17).

FIG. 17.

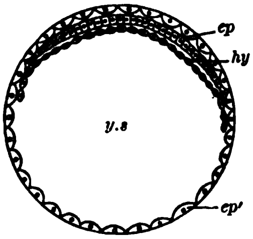


Rabbit's Ovum between Seventy and Ninety Hours after Impregnation (after E. van Beneden): *bv*, cavity of blastodermic vesicle or yelk-sac; *ep*, epiblast; *hy*, primitive hypoblast; *Zp*, layer formed by zona pellucida and swollen and degenerated cells of discus proligerus.

"Although by this stage, which occurs in the rabbit between seventy and ninety hours after impregnation, the blastodermic vesicle has by no means attained its greatest dimensions, it has nevertheless grown from about 0.09 mm. ($\frac{1}{250}$ inch)—the size of the morula at the close of segmentation—to about 0.28 mm. ($\frac{1}{90}$ inch) in diameter. It is enclosed by a membrane formed from the zona radiata and the mucous layer around it. The blastodermic vesicle continues to enlarge rapidly, and during the process the hypoblastic mass undergoes important changes. It spreads out on the inner side of the epiblast, and at the same time loses its lens-like form and becomes flattened. The central part of it, however, thickens, and becomes constituted of two rows of cells, while the peripheral part, the outer boundary of which is irregular, is formed of an imperfect layer of amœboid cells, which continually spread farther and farther within the epiblast. The central thickening of the hypoblast forms an opaque circular spot on the blastoderm, which constitutes the commencement of the *embryonic area.*"

The structure of the developing ovum at this stage is diagrammatically represented in Fig. 18. It is three layers thick in the embryonic area. The outer cells at this region, derived from the primitive epiblast layer, are known as the *cover-cells.* They do not directly share in the formation of the embryo. The rest of the primitive epiblast (non-embryonic epiblast, *ep'*) helps to form the amnion and umbilical vesicle. (See p. 126.) The second layer of cells in the embryonic layer, *ep*, becomes the *epiblast* of the embryo proper; the innermost layer is the *hypoblast* proper (*hy*). The covering cells soon disappear, so that the embryonic epiblast becomes superficial. Whether the cover-cells fuse into it and help to form it, or are used in forming the fœtal membranes, is not known. Later on we shall find that in the embryonic area a third layer of cells, the *mesoblast*, develops between the hypoblast and the embryonic epiblast; but before proceeding further with the account of the development of the mammalian it is desirable to consider briefly the corresponding processes in the hen's egg, as only then can certain of the phenomena observed in Mammalia be properly understood.

FIG. 18.



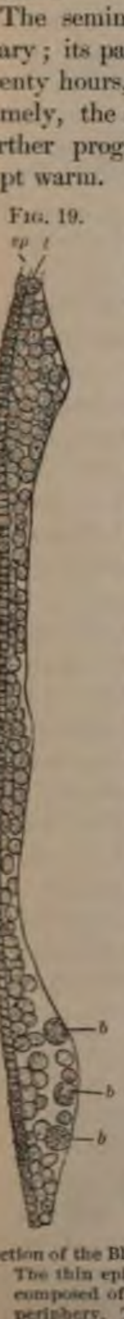
Diagrammatic Section of a Mammalian Blastoderm after the cover-cells have completely closed in the blastoderm, and the embryo proper has become two-layered: *ep'*, non-embryonic epiblast; *ep*, embryonic epiblast; *hy*, hypoblast; *y.s*, yelk-sac. (From Haddon.)

*The Early Stages of the Development of the Chick.*—The egg of the now existing higher mammals (*Eutheria*), though holoblastic itself, is undoubtedly descended from an egg which was mesoblastic and possessed a considerable quantity of food-yelk. In its present development it still gives evidence of this ancestral condition.

The egg of a hen consists of certain accessory structures—shell, shell-membranes, and white—and of the egg proper, consisting of the yelk and *vitelline membrane.* The latter corresponds to the zona radiata of the mammalian ovum. Most of the yelk is mere food-material, but on one side of it (which always comes uppermost if the fresh egg be laid on one side for a few minutes) is a special collection of germ-yelk, forming the so-called *germinal disk.* In it, before the egg is quite matured in the ovary, can be found the germinal vesicle and germinal spot: from it are extruded, as it matures, polar bodies, essentially as in the mammal's ovum. The white, shell-membranes, and shell are added to the ovarian egg, or egg proper, as it descends through the oviduct.

The seminal fluid of the cock fertilizes the egg as it leaves the ovary; its passage from this spot to the exterior takes from fifteen to twenty hours, and during this time the earliest stages of development—namely, the segmentation of the ovum—are passed through. The further progress of development is then checked unless the egg be kept warm. Segmentation is confined to the region of the germinal disk, which region is known as the *upper pole* of the egg. Lying just under the vitelline membrane at this point we find, in a fresh-laid fertilized egg, a flat membrane resulting from the segmentation, and named the *blastoderm.*

FIG. 19.



Section of the Blastoderm of a Fowl's Egg at the Commencement of Incubation (from Balfour). The thin epiblast, *ep*, composed of columnar cells, rests on the incomplete lower layer, *l*, composed of larger and more granular hypoblast cells; this layer is especially thick at the periphery. The line below the hypoblast marks the upper surface of the food-yelk.

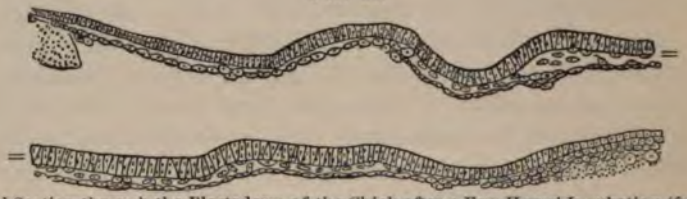
*Structure of the Blastoderm of a Fresh-laid Fertilized Hen's Egg.*—Section through the blastoderm at this period shows it to have the structure represented in Fig. 19. It consists essentially of two layers of cells. The upper forms a coherent membrane, and is the epiblast, *ep*. The cells of the lower layer, *l*, are rounded and irregularly arranged, not forming a continuous layer. Beneath them lies the food-yelk (not represented in the figure).

*The Growth of the Blastoderm of the Chick.*—As soon as incubation commences the cells of both blastodermic layers multiply by division. In addition, the lower layer is constantly joined by new cells derived from some protoplasm previously scantily diffused throughout the mass of food-yelk. These cells creep up and add themselves to the lower layer, especially near its outer margin. They are called *formative cells* (*b*, Fig. 19). The blastoderm is at first circular in outline and about the diameter of a silver half-dime, but as the number of its cells increases it spreads farther and farther around the food-yelk, which it ultimately completely envelops.

After a few hours of incubation (five or six) most of the lower cells become flattened and join by their edges to make a continuous layer (Fig. 20), the *hypoblast.* Between the hypoblast and epiblast are shut in a few irregularly-shaped cells from the primitive lower layer and from some of the formative cells. They are the first indications of an intermediate layer of the blastoderm, which ultimately becomes highly developed—namely, the *mesoblast.*

A surface view of the blastoderm at this stage presents a more transparent central circular portion, the *area pellucida,* surrounded by a more opaque rim, the *area opaca.* As incubation proceeds and the blastoderm spreads over the yelk both areas increase in size. *It is in the area pellucida that the embryo develops.*

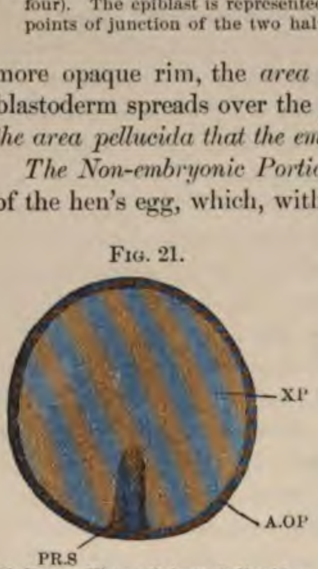
FIG. 20.



Vertical Section through the Blastoderm of the Chick after a Few Hours' Incubation (from Balfour). The epiblast is represented somewhat diagrammatically. The hyphens show the points of junction of the two halves of the section.

*The Non-embryonic Portion of the Blastoderm.*—The large food-yelk of the hen's egg, which, with the white, has to be absorbed and utilized for the nourishment of the embryo, necessitates an extension of the blastoderm far beyond the region in which the embryo itself is formed. This is the *non-embryonic* portion: it gives rise to accessory fœtal structures—the *yelk-sac* and *the amnion.*

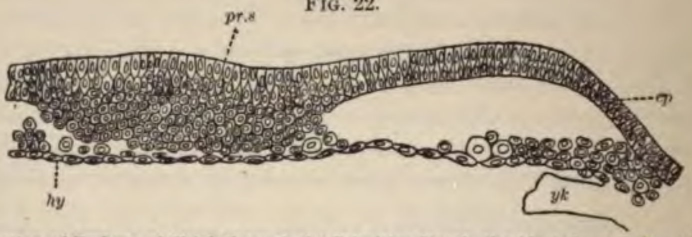
FIG. 21.



Bird's-eye View of Area Pellucida of Young Blastoderm of Chick, showing first appearance of primitive streak (from Balfour): XP, area pellucida; A.OP, inner margin of area opaca; PR.S, primitive streak.

*The Primitive Streak and Groove.*—After twelve hours of incubation, when the whole blastoderm is not larger than a dime, surface views disclose a slight opacity in one portion of the area pellucida (Fig. 21). This opacity is the *primitive streak.* Sections show that it is due (Fig. 22) to a great thickening of the mesoblast in this region, caused by multiplication of epiblast cells. The long axis of the primitive streak is at right angles to the long axis of the egg, but

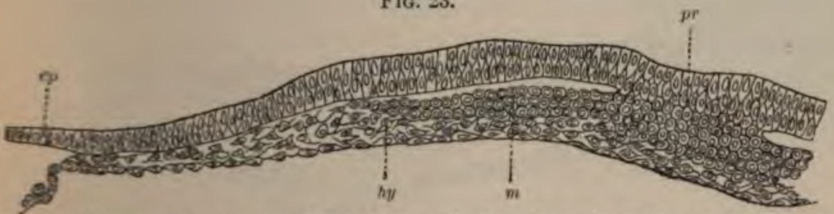
FIG. 22.



Cross-section of Embryo of Chick through the Primitive Streak, the blastoderm being of about the same age as that represented in Fig. 21 (from Balfour). The section passes across the middle of the primitive streak: *pr.s,* primitive streak; *ep,* epiblast; *hy,* hypoblast.

coincides with the long axis of the future embryo. The embryo, however, develops entirely in front of the primitive streak, the front end

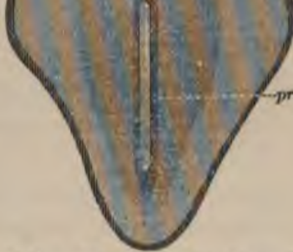
FIG. 23.



Vertical Transverse Section through Primitive Streak of Developing Hen's Egg, after the lateral outgrowths of the mesoblast have commenced: *pr*, primitive streak and commencing primitive groove; *m*, mesoblast; *ep*, epiblast; *hy*, hypoblast (from Balfour. Most of the right half of the section is omitted, the middle line of the blastoderm being at *pr*).

of which corresponds to its tail end. Along its axis the mesoblast of the primitive streak remains for some time continuous with the epiblast: but its cells multiply and spread laterally (Fig. 23, *m*), and there form a separate layer. After about sixteen hours of incubation the area pellucida is seen to have increased considerably in size and to have become pear-shaped. Along its axis appears a superficial furrow, the primitive groove (*pr*, Fig. 24).

FIG. 24.



Surface View of Blastoderm of Chick after the Primitive Groove has been Formed (from Balfour): *pr*, primitive streak, with primitive groove; *af*, amniotic fold. The slightly darker shading around the primitive streak indicates the lateral extension of the mesoblast in this region.

The primitive groove and streak are transient structures in the chick, and are only explicable as due to heredity from ancestral forms. Comparative embryology has, in fact, afforded a satisfactory explanation of them, but it would take us too far afield to enter upon it here.[1]

*The Formation of the Mesoblast in Front of the Primitive Streak.*—In the anterior portion of the area pellucida the mesoblast has a very different origin. Some of it is derived from formative cells, but most of it is formed by multiplication of the cells of the hypoblast. These divide and give off, into the space between them and the epiblast, a number of irregularly branched cells, at first along the line of the long axis of the future embryo (Fig. 25). From this axis the mesoblast spreads as a distinct layer on each side (Fig. 26), but its continuity with the hypoblast along this axis remains for some time (*ch*), and there its cells soon become rounded and closely packed.

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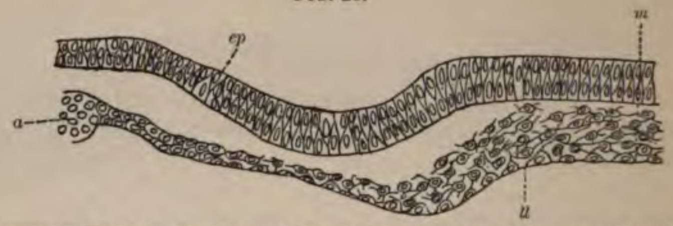
[1] See Haddon: *Introduction to Embryology*, p. 41.

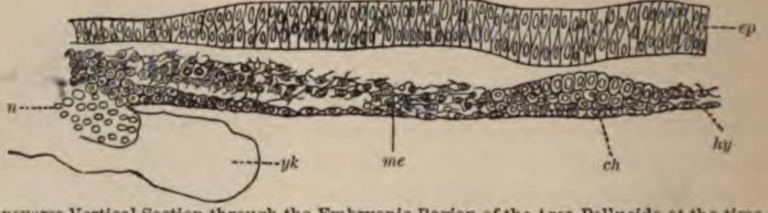
*The Formation of the Notochord.*—Next (after about eighteen hours of incubation) there occurs a fact of fundamental importance. The mesoblast cells in the embryonic area separate from the hypoblast along the antero-posterior axis of the future chick (Figs. 26, 27, *ch*), and form a distinct cellular rod, the *notochord*. This is the earliest developmental fact which plainly indicates that the embryo is that of a vertebrate animal. In the bird and mammal the spinal column and part of the base of the skull are built up around the notochord. As shown in the figure, the plates of mesoblast on the sides of the notochord are separated from it by a space containing only liquid. They are known as the *peripheral plates*.

Fig. 25.



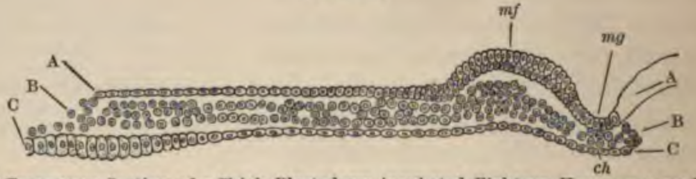
Part of Transverse Vertical Section through the Embryonic Region of the Area Pellucida of a Chick, shortly before the formation of the medullary groove and notochord: *m*, median line of section; *ep*, epiblast; *ll*, lower layer cells (primitive hypoblast) not yet quite differentiated into mesoblast and hypoplast. (From Balfour.)

Fig. 26.



Transverse Vertical Section through the Embryonic Region of the Area Pellucida at the time of the first appearance of the notochord, but after the mesoblast and hypoblast have become differentiated in the lateral parts of the embryo (from Balfour): *ch*, commencing notochord and middle of section; *ep*, epiblast; *hy*, hypoblast; *me*, mesoblast.

Fig. 27.



Half of Transverse Section of a Chick Blastoderm incubated Eighteen Hours: *mg*, medullary groove and middle line of section; A, epiblast; B, mesoblast; C, hypoblast; *mf*, medullary fold; *ch*, notochord.

*The Tissues and Organs developed from Each of the Three Primary Layers of the Blastoderm.*—The three fundamental layers of the blastoderm may now be regarded as definitely established in the embryonic area. All three will spread as the blastoderm grows and help to form fœtal appendages developed from the non-embryonic area. But, so far as the definite building of the body of the future chick is concerned, we find that in it, as in all the higher animals, each layer gives origin to certain definite tissues and organs, to these and to no others—a fact of profound importance morphologically and physiologically.

In the higher vertebrates the following structures are always derived from the *epiblast*—namely, epidermis; epithelium of mouth, epithelium of nose, and epithelium of cloaca (when present); the nerve-cells of brain, spinal cord, and ganglia; their branches, the axis-cylinders of all nerve-fibres; the neuroglia or supporting tissue of the nerve-elements in the brain and spinal cord; the retina; the lens of the eye; epithelium of the conjunctiva; the special sensory "end-organs" of nerve-fibres in ear, nose, mouth, and skin.

From the *hypoblast* are derived the cells lining the alimentary canal (except the buccal cavity and cloaca); the secreting cells of the digestive glands and the cells lining their ducts; the epithelium of the lungs and air-passages, except the nares.

From the *mesoblast* develop all the tissues of the internal skeleton, bony, cartilaginous, connective; the heart and blood-vessels; the lymphatics; the muscles; the reproductive glands; and the kidneys.

Embryology shows that the mesoblast is later in development than either of the other layers, and is derived from them, and, though so important in the higher animals, is secondary in its origin. Comparative anatomy in this respect agrees in its testimony with embryology. The simpler multicellular animals (Metazoa), such as the fresh-water hydra and its allies, consist of but two fundamental layers of cells, the ectoderm and endoderm, which correspond to epiblast and hypoblast respectively. The hydra is a mere two-layered sac: its outer-layer cells are essentially protective, motor, and sensitive, and place it in relation with its environment. Corresponding to this we find in higher animals (all of which pass through a two-layered stage in their development) that the nervous system and the essential parts of the sense-organs are epiblastic in origin. The endoderm cells of hydra, which line its cavity, are essentially nutritive cells; they secrete digestive liquid and they absorb the products of digestion. Corresponding to this fact, we find that the cells of the digestive glands and the absorbent cells of the alimentary tract are derived from hypoblast. In the course of evolution from a primitive two-layered ancestor the mesoblast has been developed, partly from each of the other layers: they have relegated to this third layer such functions as do not imply immediate contact with the environment or with food-materials; so the mesoblast has come to form the supporting tissues, the motor organs, and the organs for distributing absorbed nourishment and oxygen; for preparing sexual cells; for separating wastes from the blood to be transferred to the exterior, usually through passages, in part at least, still lined by epiblast.

*The Gastrula Theory.*—The theory that the two-layered stage through which all the higher animals pass in the course of their development is an inheritance from a simpler ancestral form which never possessed more than two layers of cells, is known as the *gastrula theory*, and is generally accepted by biologists.

*The Formation of the Medullary Folds and Groove.*—At about the time when the notochord is formed the epiblast is found to have become (Fig. 27) two or more layers of cells thick on each side of that structure. A similar thickening occurs in front of the notochord. These thickenings give rise to two ridges which run parallel to one another along the sides of the anterior portion of the notochord and converge and meet in front of it (Fig. 28). These ridges are the beginnings of the *medullary folds*, and the trough between them is the *medullary groove*. The folds at first diverge behind and embrace between them the front end of the primitive groove; but they soon converge again (Fig. 29) and

FIG. 28.

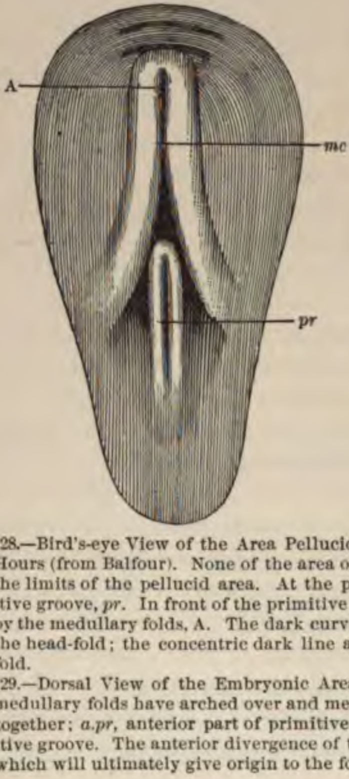


FIG. 29.

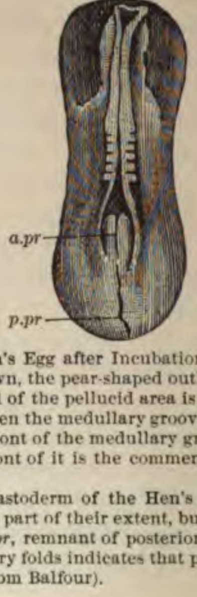


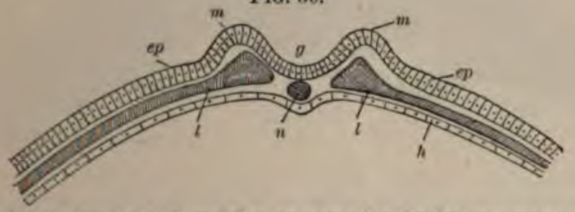
FIG. 28.—Bird's-eye View of the Area Pellucida of a Hen's Egg after Incubation for Eighteen Hours (from Balfour). None of the area opaca is shown, the pear-shaped outline indicating the limits of the pellucid area. At the posterior end of the pellucid area is seen the primitive groove, *pr*. In front of the primitive groove is seen the medullary groove, *mc*, bounded by the medullary folds, A. The dark curved line in front of the medullary groove indicates the head-fold; the concentric dark line a little in front of it is the commencing amniotic fold.

FIG. 29.—Dorsal View of the Embryonic Area of the Blastoderm of the Hen's Egg, after the medullary folds have arched over and met for a great part of their extent, but not yet fused together; *a.pr*, anterior part of primitive groove; *p.pr*, remnant of posterior part of primitive groove. The anterior divergence of the medullary folds indicates that portion of them which will ultimately give origin to the fore-brain (from Balfour).

meet a little way behind the front of the primitive groove. They then quickly approximate at the region where they formerly spread apart, so that the neural groove is converted into a narrow trough closed in front and behind, and bounded by epiblastic elevations on each side.

A cross-section of an embryo at this stage, in the region which is ultimately to form the dorsal region of the chick, would show the structure diagrammatically represented in Fig. 30.

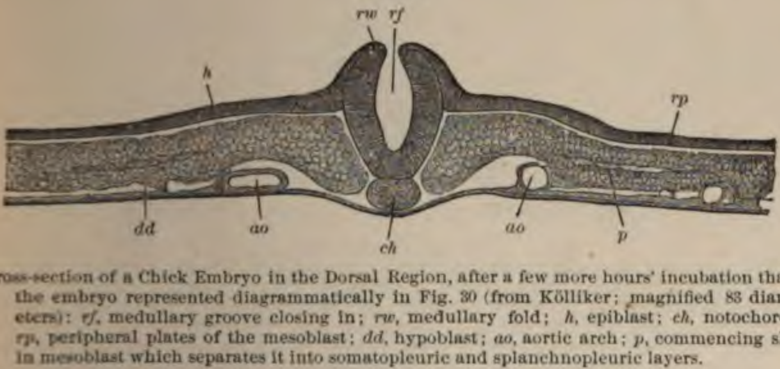
FIG. 30.



Cross-section of an Embryo in the Dorsal Region soon after the first appearance of the medullary folds (diagrammatic): *g*, medullary groove; *m*, *m*, medullary folds; *n*, notochord; *l*, peripheral plates of mesoblast; *ep*, epiblast; *h*, hypoblast. (The shading of the figure is very diagrammatic.)

In Fig. 31 is represented a later stage of development. The medullary folds have risen higher and begun to bend over toward one another.

FIG. 31.



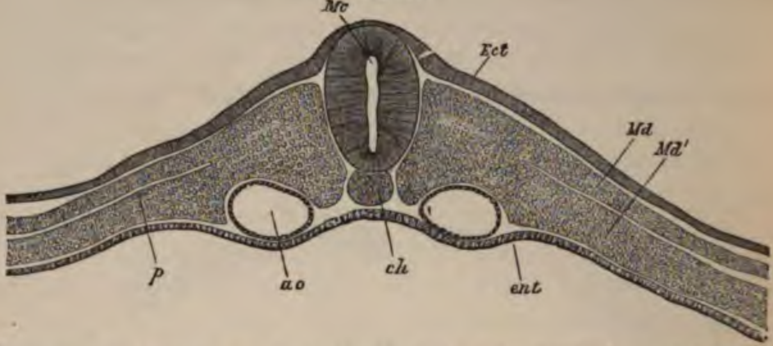
Cross-section of a Chick Embryo in the Dorsal Region, after a few more hours' incubation than the embryo represented diagrammatically in Fig. 30 (from Kölliker; magnified 83 diameters): *rf*, medullary groove closing in; *rw*, medullary fold; *h*, epiblast; *ch*, notochord; *rp*, peripheral plates of the mesoblast; *dd*, hypoblast; *ao*, aortic arch; *p*, commencing slit in mesoblast which separates it into somatopleuric and splanchnopleuric layers.

A little later (Fig. 32) they meet, and their edges fuse in the middle line. The medullary groove is thus converted into the medullary tube or *neural canal*, which is lined by epiblast. Very soon the epiblast covering in the tube separates as a distinct layer from that lining the canal, though for some time the two remain in contact, as shown in Fig. 32.

The folds first meet (Fig. 29) near their anterior ends, in what subsequently becomes the posterior part of the head region of the chick. From this point the closure of the canal rapidly proceeds forward, and more slowly backward, so that the groove is open toward the tail for some hours after it has been closed anteriorly.

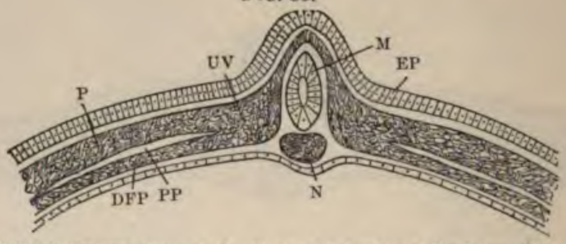
From the epiblast lining the neural canal are developed the brain, retina, spinal cord, the axis-cylinders of all the nerve-fibres, and probably all the ganglion-cells of the body. The cavity of the tube persists throughout life as the central canal of the spinal cord and as the fourth, third, and lateral ventricles of the brain and the passages uniting them.

FIG. 32.



Cross-section of a Chick Embryo in the Cervical Region (after Kölliker, magnified 104 diameters): *Mc*, medullary tube, or rudiment of spinal cord; *Ect*, epiblast, which will form epidermis; *Md*, part of mesoblast which adheres to epiblast to form the splanchnopleure; *p*, the commencing pleuroperitoneal cavity; *ent*, the hypoblast; *ao*, aortic arches; *ch*, notochord; *Md'*, splanchnic layer of mesoblast.

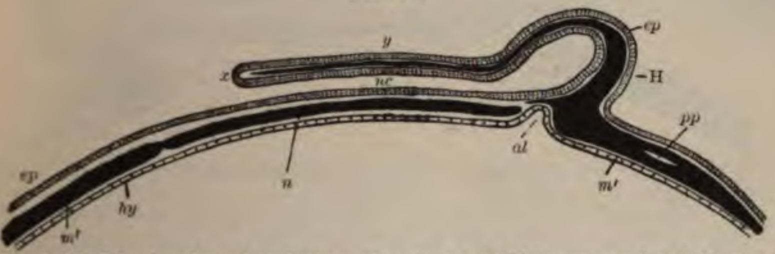
FIG. 33.



Cross-section of Chick Embryo through the Region of the Dorsal Vertebræ, after the closure of the neural canal and the extension of the mesoblast between it and those epiblastic cells, which remain in the exterior of the body and form the epidermis (the figure is very diagrammatic, and should be studied in connection with Figs. 30, 31, and 32): EP, epiblast; M, enclosed part of epiblast lining neural canal; UV, undivided portion of mesoblast; P, mesoblastic layer of body-wall; DFP, mesoblastic layer of intestinal wall; PP, commencing pleuroperitoneal cavity; N, notochord.

*Formation of the Head-fold.*—Soon after the medullary folds have appeared that portion of the blastoderm which lies near their anterior end begins to rise up in the form of a fold above the general level of the rest of the blastoderm. It carries, of course, the medullary groove with it. (See Fig. 29.) After the front end of the groove is closed the brain part of the neural canal lies above this tucked-up or folded-off piece of the blastoderm, which is named the "head-fold." The diagram (Fig. 34) will aid in understanding the relations of the head-fold at this time. The figure represents a longitudinal section of the embryo soon after the appearance of the head-fold, but before the hinder end of the neural canal is closed in: *nc* is the neural canal with lining epiblast of its roof continuous still at its posterior opening with the external epiblast, and the lining epiblast of its floor continuous with the epiblast, which runs off to spread over the yelk. Beneath the neural canal is the notochord, *ch:* it will be noticed that it does not reach to the front of the head-fold or neural canal, but in that region is represented by a rather thick layer of mesoblast. At the tail end of the embryo, where the notochord ends, *x*, there is also a thick layer of mesoblast, that of the primitive streak. The head-fold is hollow, *al*, and its cavity lined with hypoblast and filled with yelk.

FIG. 34.



A Longitudinal Section through an Embryo, after the head-fold has appeared and the medullary folds have met and closed in the front end of the neural canal, but are still divergent behind; a cross-section at *y* would give Fig. 33 (diagrammatic). If the medullary folds in Fig. 29 be imagined to have completely met and fused in the cranial, cervical, and anterior dorsal regions, Fig. 34 may be taken as the diagrammatic longitudinal section of the embryo represented in Fig. 29. H, head-fold; *ep*, external epiblast; *nc*, neural canal, lined by involuted epiblast; *x*, the point at which the medullary folds diverge and the neural canal is still open; *m*, mesoblast behind the embryonic region of the blastoderm; *n*, notochord; *m'*, mesoblast in front of embryonic region of the blastoderm; *hy*, hypoblast; *al*, beginning of alimentary canal (pharynx).

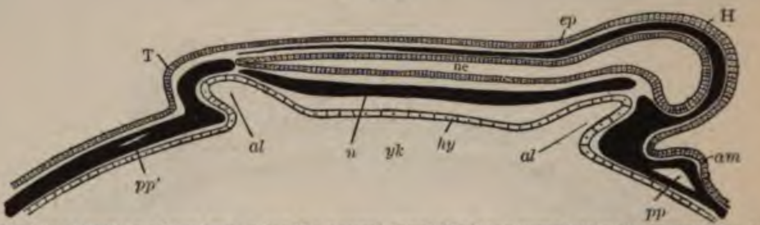
*Formation of the Tail-fold.*—A little later we should find the neural canal completely closed behind as well as in front, and at the tail end a fold appearing much like the head-fold, but smaller. The diagram (Fig. 35) will serve to indicate the relations at this stage.

The short tubes *al* and *al'* ultimately develop into the pharynx and rectum respectively: the buccal cavity burrows from the under side of the head-fold into the embryonic pharynx, and the cloaca similarly makes its way from the exterior to the rectum of the embryo (*c*, Fig. 43).

*The Side-folds.*—The embryo in the stage last figured had been tucked or folded off from the plane of the blastoderm in front and behind, but its middle region still lay nearly in the general plane of the blastoderm. A diagrammatic cross-section at this period of what will become the dorsal region of the bird is shown in Fig. 33.

Soon after the appearance of the head- and tail-folds, foldings begin on the sides of the embryo; they are continuous with the head- and tail-folds: a cross-section of the dorsal region at this stage would be somewhat as shown in Fig. 36.

FIG. 35.



Longitudinal Section of Embryo, after the neural canal has been completely closed and the tail-fold has appeared (diagrammatic): H, head-fold; T, tail-fold; *ep*, external epiblast; *ne*, neural canal lined by involuted epiblast; *pp*, mesoblastic cleft commencing to expand and form the amnion; *pp'*, commencement of mesoblastic cleavage in the tail region; *am*, commencing amniotic fold (compare Fig. 40); *n*, notochord; *al*, front end (pharynx) of primitive alimentary canal; *al'*, posterior end (rectum) of primitive alimentary canal.

FIG. 36.

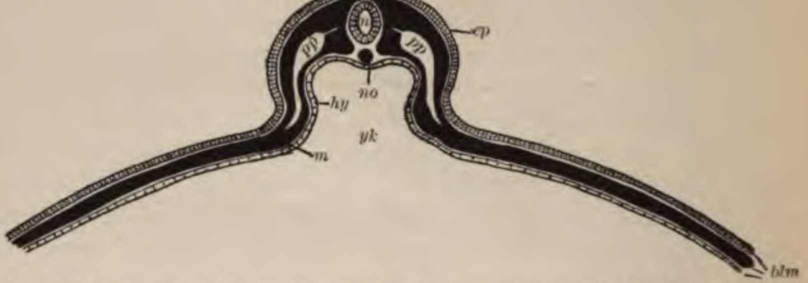


Diagram of Cross-section of Embryo soon after the Origin of the Side-folds (compare with Figs. 30 and 33): *ep*, external epiblast; *n*, neural canal (spinal cord) lined by involuted epiblast; *no*, notochord; *m*, mesoblast; *hy*, hypoblast· *blm*, peripheral non-embryonic blastoderm, with its three layers, forming the primary yelk-sac: *yk*, food-yelk; *pp*, pleuroperitoneal cavity or mesoblastic cleft, much wider when compared with the same in Fig. 33: its innermost portion does not widen, and, remaining a narrow cleft, soon becomes indistinct; traces of it may, however, be found later in the mesoblastic somites (Fig. 65).

These new foldings, known as the *side-folds* or *lateral folds*, serve, with the head- and tail-folds, to separate off a smaller upper cavity of the blastoderm from a much larger lower part (non-embryonic part) which spreads over the food-yelk. There is, however, at this stage a free communication between the two cavities, and the smaller or embryonic one contains food-yelk as well as the larger.

If, now, the under side (Fig. 35) of the head-fold were to grow backward, and the under side of the tail-fold forward, and the converging parts (Fig. 36) of the side-folds inward, there would be shut off more and more an upper smaller cavity from a lower and much larger. Ultimately, the folds would all meet at one point, and if they coalesced there would completely shut off the upper cavity. The diagrams below will illustrate this condition (Figs. 37 and 38).

FIG. 37.

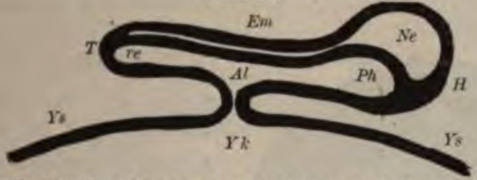


Diagram illustrating the Meeting of the Head- and Tail-folds at the Navel to close off the embryo from the yelk-sac cavity. No attempt has been made to indicate the various layers of the blastoderm. *Em*, embryonic tube; *Ys*, part of yelk-sac; *Yk*, food-yelk; *Al*, alimentary canal, nearly closed; *ph*, embryonic pharynx; *re*, embryonic rectum; the buccal and anal openings are pitted in from the exterior at a much later stage of development; H, head-fold; T, tail-fold; *Ne*, neural canal.

FIG. 38.

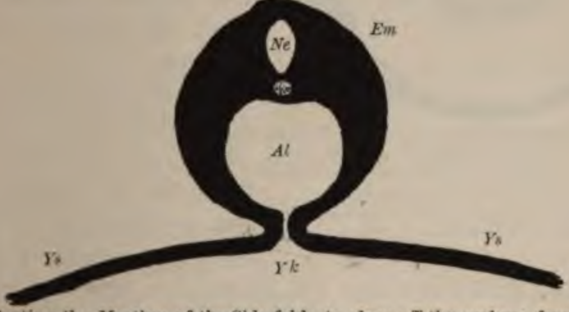


Diagram illustrating the Meeting of the Side-folds, to close off the embryo from the yelk-sac; *Ys*, part of yelk-sac; *Yk*, food-yelk; *Al*, alimentary canal; *Em*, embryo; *Ne*, neural tube.

In essentials the folds do grow in this way and meet at the navel, there again to diverge and spread over the yelk. The smaller cavity thus loses direct communication with the larger cavity surrounded by the non-embryonic part of the blastoderm: its lining hypoblast gives rise to the epithelium of the alimentary canal, to the gland-cells of the liver and pancreas, and to the epithelium of the lungs and air-passages.

*The Cleavage of the Mesoblast and the Separation of the Body-wall and Alimentary Tube.*—Such a cross-section as is represented in Fig. 38 would, supposing the alimentary tube to have become quite closed below and the yelk-sac got rid of, fairly well represent diagrammatically a cross-section of the neck of the adult bird. In that region of the body we could pass a needle from the epidermis outside to the epithelium of the gullet inside without traversing any body-cavity. But in the thoracic and abdominal regions this is not possible: in them, to get from the skin to the alimentary canal the *body-cavity* (*pleuroperitoneal cavity* or *cœlome*) must be traversed. A diagrammatic cross-section of the adult bird in the abdominal region would not be represented fairly by Fig. 38, but rather by some such diagram as Fig. 39.

We have then to seek the origin of this great body-cavity. In the bird the thoracic and abdominal cavities remain continuous throughout life: in the mammalian embryo also the cœlome is undivided at first, though afterward subdivided by the diaphragm. The development of the cœlome is closely associated with that of the amnion, which is at first a part of it.

Fig. 39.

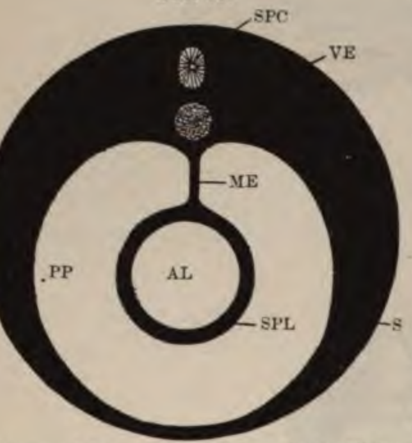


Diagram of Cross-section of One of the Higher Vertebrates in the Abdominal Region: SPC, spinal cord; VE, centrum of a vertebra; ME, mesentery; AL, intestinal cavity; SPL, wall of intestine; SO, body-wall; PP, body-cavity (cœlome).

The mesoblast of the embryonic region of the blastoderm we have seen (*p*, Figs. 27 and 30) to very early separate into a central axial rod, the *notochord*, and two *peripheral* plates. These plates are at first completely continuous from their inner to their outer surface, but even before the side-folds rise up, a cleft appears in the mesoblast, separating each plate into an inner and outer layer of cells. This cleft (Figs. 34, 35, *pp*) lies quite beyond the head- and tail-folds, but (Figs. 32, 33, 36, *pp*) it reaches in the side-folds to near the notochord and neural tube. The outer layer tends to adhere to the epiblast and to follow it in its foldings; the inner, to the hypoblast and follow it. The innermost, or most medial portion of the mesoblastic cleft (see Fig. 36), remains narrow and soon disappears; but more peripherally the cleft widens to form the body-cavity (*pp*, Fig. 36) and the amnion.

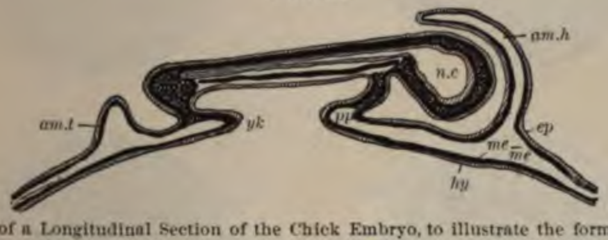
The outer layer of the divided mesoblast, which adheres to the epiblast, forms with it the *somatopleure*, from which the lateral and ventral walls of the trunk are developed (Fig. 36). The inner layer of mesoblast joins the hypoblast and forms with it the *splanchnopleure*, which in the embryonal region of the blastoderm gives rise to the coats of the greater part of the alimentary canal. Its non-embryonic portion forms the secondary or true yelk-sac (Fig. 42).

*The Development of the Amnion.*—The first trace of the amnion is (*am*, Fig. 35) a divergence of the somatopleure from the splanchnopleure a little way in front of the head-fold of the embryo. As seen in Fig. 28, this upgrowth is concentric with the head-fold at first.

At a somewhat later stage (Fig. 40) the amniotic upgrowth (*am.h*) in the head-region increases rapidly, and arches over the head of the embryo, while a similar upgrowth of the somatopleure (*am.t*) commences behind the tail of the chick.

The amniotic tail-fold grows forward over the back of the embryo; the amniotic head-fold grows backward; finally, they meet and fuse

FIG. 40.



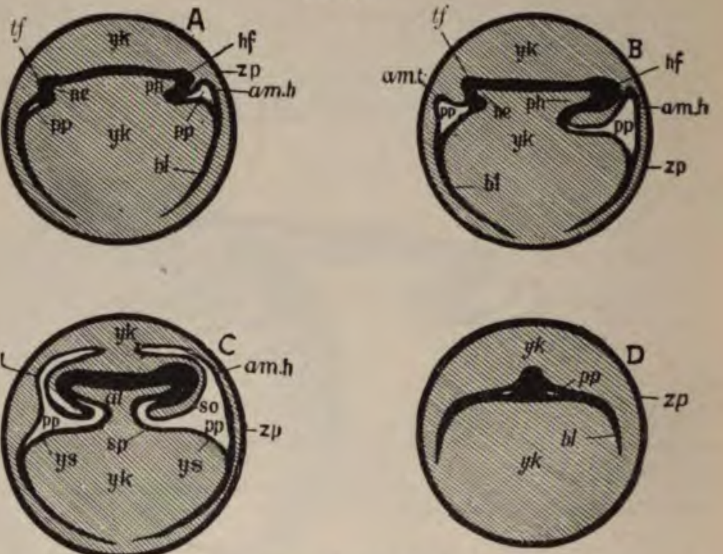
A Diagram of a Longitudinal Section of the Chick Embryo, to illustrate the formation of the amnion: *n.c*, brain dilatation of the anterior end of the neural tube, lined by its involuted epiblast; *am.h*, head-fold of amnion; *am.t*, tail-fold of amnion; *pp*, pleuroperitoneal cavity; *ep*, external epiblast; *me*, outer layer of mesoblast, which adheres to epiblast to form the somatopleure; *hy*, hypoblast; *me*′, inner layer of mesoblast, which adheres to hypoblast to form with it the splanchnopleure; *yk*, food-yelk.

(see A, B, C, Fig. 41; A, Fig. 42; also Fig. 43). Meanwhile, amniotic side-folds have appeared (see D, E, F, G, H, Fig. 41, and B, Fig. 42), continuous in front and behind with the amniotic head- and tail-folds; these gradually grow up over the back of the embryo, and, meeting the other folds, fuse with them and enclose the tail, head, and back of the chick in a double-walled sac of somatopleure containing a cavity continuous with the pleuroperitoneal cavity and with the cleft in the mesoblast, which is gradually spreading all over the non-embryonic region of the blastoderm. The diagrams given in Figs. 41, 42, 43 will make the stages of development clearer than many pages of mere verbal description. It must be borne in mind that the figures are the merest diagrams, and that every other contemporary detail in the embryonic development has been sacrificed in order that the various stages in the growth of the amnion may be made more obvious.

In A, Fig. 41, the head- and tail-folds of the embryo are indicated (*hf*, *tf*), and the commencing enclosure of the front end (*ph*) and hind end (*ne*) of the alimentary canal; also, the pleuroperitoneal clefts (*pp*) in the mesoblast in front of the head-fold and beyond the tail-fold. In the head region the somatopleure is seen to have commenced its upward growth to form the first indication of the head-fold of the amnion (*am.h*).

In B, which also represents a longitudinal section, the amniotic head-fold is seen to have increased in size, and the amniotic tail-fold to have commenced (*am.t*). Meanwhile, the non-embryonic region of the blastoderm (*bl*) has spread farther round the food-yelk. In all the diagrams in Fig. 41 the distance between the embryo and the zona pellu-

FIG. 41.



Eight Diagrams to Illustrate the Origin of the Amnion, and its relationship to the primary body-cavity (pleuroperitoneal cavity, cœlome) in the bird embryo. The size of the embryo is much exaggerated in the figures, as also the distance between it and the zona pellucida, and between the latter and the non-embryonic region of the blastoderm. A more detailed account of what the diagrams are intended to make clear will be found in the text.

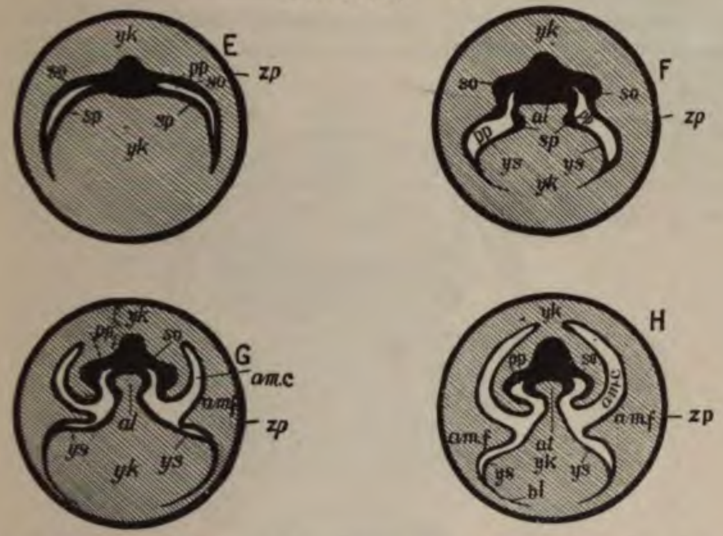
*yk*, food-yelk; *zp*, zona pellucida; *hf*, head-fold of embryo; *tf*, tail-fold of embryo; *am.h*, head-fold of amnion; *am.t*, tail-fold of amnion; *pp*, pleuroperitoneal cavity; *so*, somatopleure;

cida (*zp*) is much exaggerated, and also the space between the non-embryonic blastoderm and the zona.

In C, Fig. 41, the amniotic head- and tail-folds are shown as having greatly increased in size, and as having nearly met over the dorsal region of the embryo, while the cleft in the mesoblast is seen to have extended through the non-embryonic part of the blastoderm for some distance, giving rise to a considerable cavity (*pp*), which is now continuous with the future pleuroperitoneal space on the one hand, and with the primary amniotic cavity on the other.

The remaining diagrams in Fig. 41 represent cross-sections of the embryo and illustrate the development of the side-folds of the amnion. In D is shown the commencement of the pleuroperitoneal cleft. In E the mesoblastic cleavage is represented in a more advanced stage, when it has spread some distance over the non-embryonic region of the blastoderm. In F are indicated the thickening of somatopleure and splanchnopleure in the embryonic region, and the folding off of the embryo from the general plane of the blastoderm. In G the side-folds of the amnion are represented as well advanced, and the embryo as still further differentiated from the non-embryonic area. In H the side-folds of the amnion are seen to have almost met over the back of

Fig. 41 (*bis*).

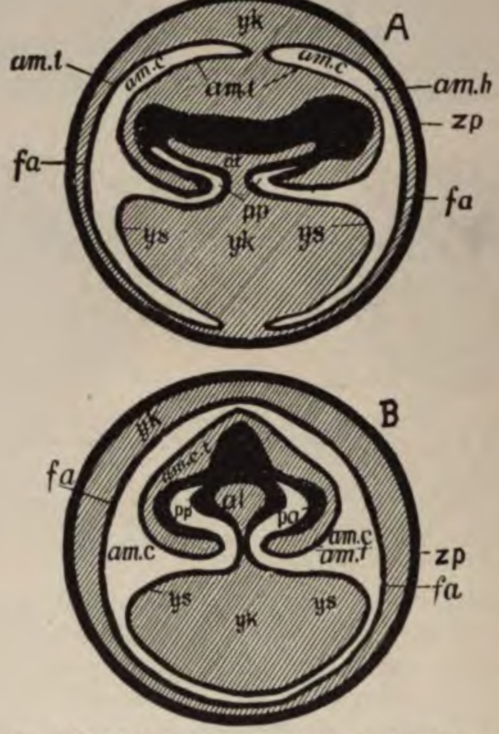


*sp*, splanchnopleure; *ys*, yelk-sac; *ph*, commencement of formation of pharynx; *ne*, beginning of rectum; *al*, alimentary canal after the splanchopleures have curved in so as to partially enclose other of its regions, in addition to pharynx and rectum. The diagrams indicate how the false amnion (*am.f*), consisting of non-embryonic somatopleure, is separated from the true amnion above the embryo, and from the non-embryonic splanchnopleure below the embryo; this non-embryonic splanchnopleure forming the *yelk-sac*, the cavity of which remains for a time continuous with the cavity of the primitive alimentary canal by a narrow hollow tube, the *umbilical duct*.

the embryo, while the cleavage of the mesoblast has extended a considerable distance along the non-embryonic mesoblast, tending to split off the non-embryonic somatopleure (*am.f*), as the *false amnion*, from the non-embryonic splanchnopleure (*ys*, H, Fig. 41), which forms the true yelk-sac. In all the diagrams in Fig. 41 the size of the embryo in relation to the whole egg and to the yelk-sac is greatly exaggerated.

In Fig. 42 there are given diagrams illustrating later stages in the development of the amnion. A is a longitudinal section at a period when the head and tail amniotic folds have nearly met above the back of the embryo, and when the cleavage of the mesoblast has nearly spread to the lower margin of the non-embryonic blastoderm. The primary amniotic cavity (*am.c*) is seen to be continuous with the pleuroperitoneal cavity (*pp*), and the false amnion (*fa*) to have very nearly separated from the true amnion (*am.t*) above the embryo, and from the yelk-sac (*ys*) below. B, Fig. 42, represents a transverse section of the embryo when the amniotic folds have met and fused over the embryo. The inner layers (*am.t*) of the primary amnion have joined to form the true *amnion* and enclose the true amniotic cavity (*am.c.t*). The outer layers (*fa*) of the primary amnion have met and united above the embryo, and a continuation of the mesoblastic cleft over the whole non-embryonic blastoderm has entirely separated them and their extensions over the food-yelk from the embryo and from the yelk-sac (*ys*), to form

FIG. 42.



A, Longitudinal Section of Bird Embryo (diagrammatic) just before the head and tail amniotic folds have met over the back of the chick: the yelk-sac (*ys*) is almost completely separated from the false amnion, *fa*, by extension of the primary amniotic cavity, *am.c*, through the non-embryonic blastoderm; *zp*, zona pellucida; *am.h*, head-fold of amnion; *fa*, false amnion; *am.t*, true amnion, nearly enclosing the true amniotic cavity; *pp*, pleuroperitoneal cavity, continuous with the primary amniotic cavity; *yk*, yelk; *ys*, yelk-sac.

B, Diagram of Cross-section of Embryo after the side-folds of the amnion have met over its back (compare with H, Fig. 41). The mesoblastic cleft has entirely separated the yelk-sac from the false amnion; the communication between the primitive alimentary canal (*al*) and the cavity of the yelk-sac is nearly closed, the two only communicating by a narrow stalk; *zp*, zona pellucida; *fa*, false amnion; *am.t*, true amnion; *am.c.t*, cavity of true amnion; *am.c*, cavity of primitive amnion, continuous with pleuroperitoneal cavity, *pp*; *pa*, part of somatopleure which will form outer walls of body-cavity; *al*, alimentary canal, nearly closed below, and bounded on its sides by those portions of the splanchnopleure which will ultimately form the walls of most of the alimentary canal; *ys*, peripheral splanchnopleure, forming the yelk-sac; *yk*, chief mass of food-yelk: this is actually much larger in proportion to the embryo than represented in the diagram.

the separate layer known as the *false amnion* (*fa*). The splanchnopleures have nearly met below the intestine (*al*), so as to shut off the cavity of the yelk-sac from direct communication with the cavity of the alimentary canal. Those portions of the somatopleures (*pa*) which will ultimately form the body-walls of the embryo have not yet converged as much as the splanchnopleures, so that a space is left between the narrow stalk of the yelk-sac and the point where the somatopleure is reflected on each side to form the true amnion; through this space the pleuroperitoneal cavity (*pp*) is in free communication with the cavity (*am.c*) of the primitive amnion.

In Fig. 43 is represented a longitudinal section of a bird embryo after the head and tail amniotic folds have met and after the false amnion has been completely separated from the yelk-sac (compare with B, Fig. 42). The diagram also indicates the commencing epiblastic involution, *b*, which will ultimately open into the anterior end of the primitive alimentary canal and form the buccal cavity (*stomadæum*); the epiblastic ingrowth, *c*, which will ultimately open into the hinder end of the alimentary canal and form most of the cloaca (*proctodæum*); and the commencement of the allantois as a tubular outgrowth from the ventral side of the posterior portion of the alimentary tube. The allantoic tube subsequently grows forward in the pleuroperitoneal cavity, and, passing through the space between the stalk of the yelk-sac and the point where the tail-fold of the true amnion turns back, extends into the primitive amniotic cavity, *am.c*, to form, in mammals, the fœtal portion of the placenta.

FIG. 43.

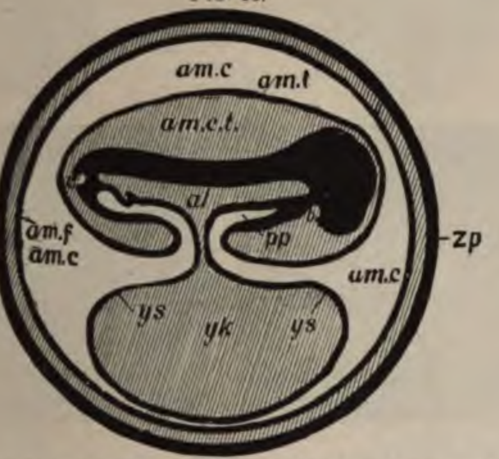


Diagram of a Longitudinal Section of an Embryo Chick, after the false amnion has been entirely separated from the true amnion and from the yelk-sac (compare with A, Fig. 42): *zp*, zona pellucida; *am.f*, false amnion: *am.t*, true amnion; *am.c*, primitive amniotic cavity, continuous with the pleuroperitoneal cavity, *pp*; *al*, alimentary canal; *b*, commencement of buccal cavity as an involution from the surface of the embryo beneath its head-fold; *c*, commencement of cloaca as an involution from the exterior of the tail-fold; *am.c.t*, true amniotic cavity; *yk*, food-yelk; *ys*, yelk-sac, continuous with the splanchnopleure, which will ultimately form the walls of most of the alimentary canal.

*The Meaning of the Formation of the Blastodermic Vesicle of the*

*Higher Mammals.*—We may now return to the consideration of the developing oosperm of the rabbit. When last studied it consisted of an embryonic area (Fig. 17, *hy*) and of a non-embryonic set of cells, *ep*, which surrounded the cavity of the blastodermic vesicle, and had also, as the *cover-cells*, grown over the original exposed portion (p. 102) of the true embryonic portion of the blastoderm. These cover-cells, it was stated, took no further distinctive part in the formation of the embryo; they were either absorbed or they fused with the true embryonic epiblast. In Figs. 44 and 45 are depicted embryonic rabbits at this stage of development: the embryos were taken from the uterus seven days after coition. Fig. 44 is a view of the developing oosperm from above; it shows the germinal area, *ag* (=area pellucida of chick), and the limit to which the hypoblast, *ge*, has spread beneath the blastodermic vesicle; also the zona pellucida, *mo*. Fig. 45 is a side view of the same embryo, the zona pellucida being omitted; *ag* is again the germinal area, and *ge* points to the limit of the extension of the hypoblast beneath the non-embryonic epiblast at this epoch.

FIG. 44.

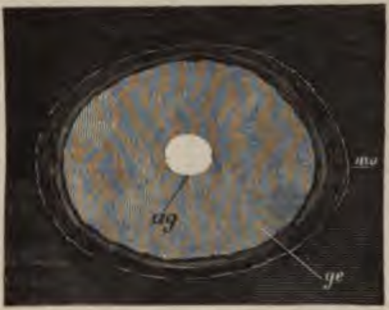


FIG. 45.

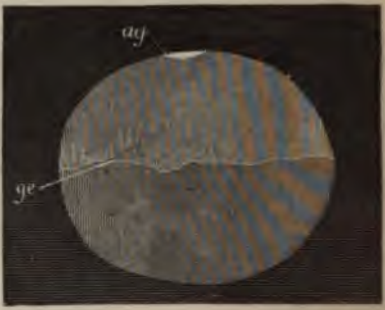


FIG. 44.—Rabbit's Embryo, taken from the uterus seven days after fertilization, seen from above (the blastodermic vesicle was 3.47 mm. in length): *mo*, remnant of zona pellucida; *ge*, limit of extension of hypoblast beneath blastodermic vesicle; *ag*, embryonic area or germinal area.
FIG. 45.—The Same Embryo as in Fig. 44, viewed from one side (the zona pellucida has been removed): *ag*, embryonic area; *ge*, peripheral limit of hypoblast (from Kölliker). Both figures magnified about ten diameters.

In the embryonic or germinal area a primitive streak and groove next make their appearance, much as in the area pellucida of the developing bird embryo (Fig. 24). As seen in the rabbit, these structures are represented in Figs. 46 and 47.[1]

In order to understand the mode of segmentation of the ovum of higher mammals and the meaning of the blastodermic vesicle, we must bear in mind that the earliest and ancestral mammals were oviparous—that they laid eggs containing much food-yelk and much like the eggs of reptiles and birds. The lowest existing Mammalia (echidna, ornithorhynchus) still lay such eggs, and their embryos are developed outside of the body of the mother, as the embryo chick is. In the marsupials (kangaroos, opossums) the embryo undergoes only a very small part of its development within the uterus; it is born inactive, unable even to suck (the milk being pumped into its gullet by a special muscle covering the maternal mammary gland), and in a condition answering to an early aborted human fœtus. In all the higher mammals (eutheria) the food-yelk is reduced to a minimum, and the embryo is retained and nourished within the womb of its mother until its development is far advanced; but even in these the earliest stages of embryonic development indicate descent from ancestors which laid meroblastic eggs.

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[1] The primitive streak and groove of embryonic reptiles, birds, and mammals are remnants of an ancestral structure, the *blastopore*. (See Balfour: *Comp. Embryol.*, vol. ii. pp. 187 and 238.)

FIG. 46.

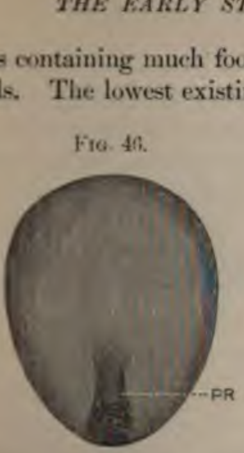


FIG. 47.

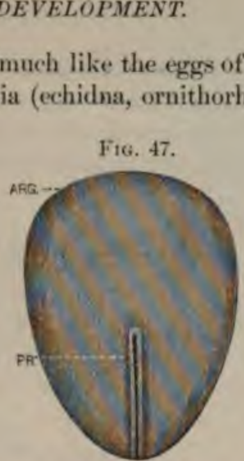
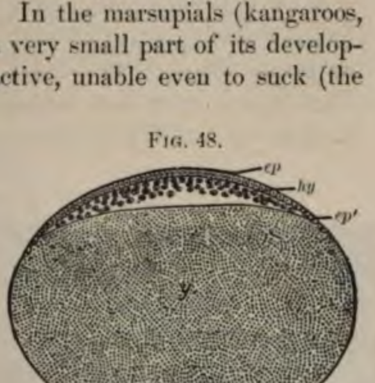


FIG. 46.—Germinal or Embryonic Area of Rabbit Embryo of seven days, seen from above (magnified about 30 diameters): *pr*, primitive streak.

FIG. 47.—Embryonic Area of Rabbit Embryo eight days after coition: *pr*, primitive streak, with primitive groove formed along it.

FIG. 48.



(From Haddon): Diagrammatic Transverse Section through the Blastoderm and Yelk of the Oosperm of a Hypothetical Primitive Mammal: *ep*, epiblast of future embryo; *ep'*, non-embryonic epiblast, which is surrounding the yelk; *hy*, primitive hypoblast; *y*, food-yelk.

The facts at present known seem to indicate that the primitive mammalian ovum (and probably still that of echidna and ornithorhynchus) had some such structure as is indicated in Fig. 48. To quote from Haddon[1] (with whom Minot in the main agrees): "The [segmenting] oosperm of a primitive mammal, . . . . in which the [food-] yelk was still present, is represented in Fig. 48. The blastoderm, which rests upon the [food-] yelk, consists of an epiblastic layer and a mass of lower

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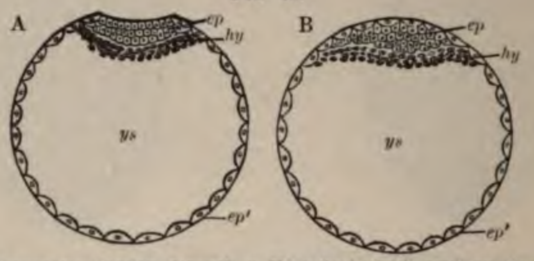
[1] *Introduction to the Study of Embryology*, p. 47.

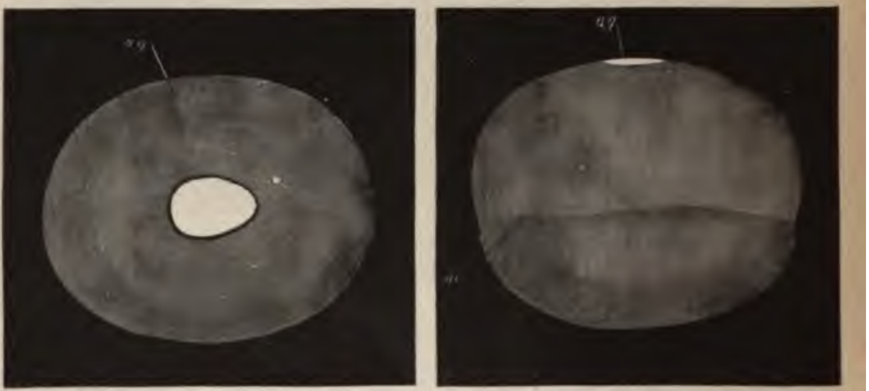
cells; the [food-] yelk is being surrounded by the non-embryonic epiblast." "A [segmenting] oosperm in which the [food-] yelk is supposed to have been lost is shown in Fig. 49, A." Owing to the absence of food-yelk, the non-embryonic area of the epiblast, having nothing to grow around, "has precociously completed the blastodermic vesicle, and the [embryonic portion of the] blastoderm has sunk into the cavity of the empty [blastodermic vesicle]." The non-embryonic epiblast then (Fig. 49, B) grows over the embryonic area as the cover-cells (p. 104). In this way would arise something very like what we actually find to occur in the early stages of the development of the rabbit (Figs. 16 and 17) and some other higher mammals.

FIG 49.



Diagrammatic Transverse Section through a Hypothetical Mammalian Oosperm, after the primary layers of the blastoderm had been formed by segmentation of the fertilized egg (the food-yelk of the original mammalian ovum is supposed to have been lost): A, earlier, and B, later stage of development; *ep*, embryonic epiblast; *ep'*, non-embryonic epiblast; *ys*, cavity of blastodermic vesicle enclosed by non-embryonic epiblast (after Haddon).

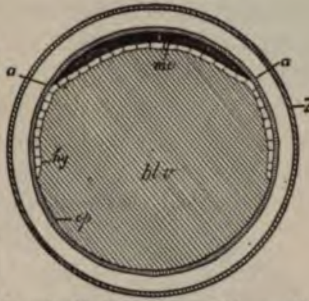
FIG. 50.



Oosperm of a Rabbit, seven days after coition, seen from above (the zona pellucida has been removed; the oosperm was 4.4 mm. in length): *ag*, embryonal area; the rest is non-embryonic blastoderm (magnified 10 diameters) (from Kölliker).

If the theory of Haddon and Minot be accepted, the blastodermic vesicle must be regarded as a mere survival from a time when a food-yelk was present in all mammalian eggs. In the now-existing higher mammals it contains no yelk, but becomes filled and distended by an albuminous liquid absorbed from the uterine mucous membrane.

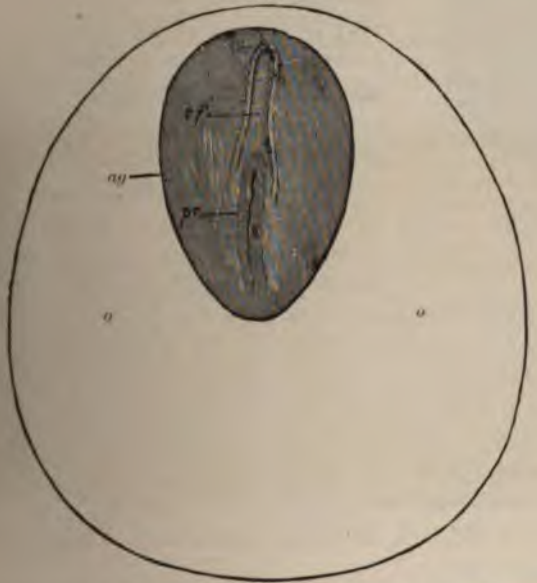
FIG. 51.



Longitudinal Section of Mammalian Embryo when the hypoblast is about halfway round the blastodermic vesicle: *a*, *a*, anterior and posterior ends of embryonic area; *zp*, zona pellucida; *ep*, epiblast; *hy*, hypoblast, *me*, mesoblast; *bl.v*, cavity of blastodermic vesicle.

*The Development of the Fœtal Membranes and Appendages of the Mammal*,[1] while in essentials similar to that of the bird, presents certain differences which we must now consider. These are, in part, due to the relatively small size and trivial importance of the mammalian yelk-sac, and to its very early completion and subsequent rapid shrinkage. From Fig. 50 may be gained some idea as to the relative extent of the embryonic and non-embryonic areas of the rabbit's oosperm at a stage shortly after the formation of the mesoblast in the embryonic region, and when the hypoblast has spread beyond that region and halfway around the embryonic vesicle.

FIG. 52.



Embryonic Area and Part of Non-embryonic Area of a Rabbit Embryo at the seventh day (from Kölliker; magnified 28 diameters): *ag*, embryonic area; *o*, neighboring part (*vascular area*) of non-embryonic blastoderm; *pr*, primitive streak; *rf*, medullary groove.

In Fig. 51 is a diagram representing a longitudinal section of an embryo in this stage. The extent of the embryonic area and of the mesoblast is, however, exaggerated, and a much wider space than actually exists is indicated between the oosperm and the zona pellucida.

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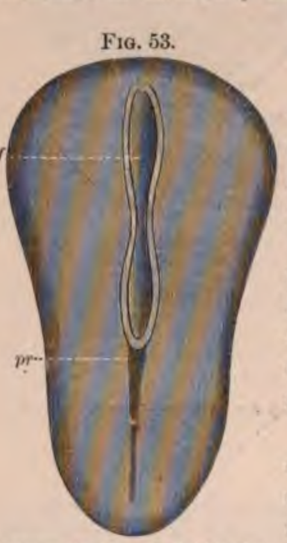
[1] In what follows the word "mammal" will be used as meaning only the *Eutheria*.

As development proceeds the hypoblast spreads, until it finally lines the whole non-embryonic epiblast; the mesoblast, spreading more slowly, ultimately does the same.

The formation of the medullary folds, groove, and canal (Figs. 52, 53), and of the notochord, and head-, tail-, and side-folds, occurs in the mammal in essentially the same manner as in the chick (p. 110), and need not be again described. The same may be said of the cleavage of the mesoblast (p. 116).

FIG. 53.



Embryonic Area of Rabbit Embryo, aged eight days and four hours (from Kölliker; magnified 20 diams.): *rf*, medullary groove; *pr*, primitive streak.

*The Mammalian Amnion* presents some peculiarities in its development which are illustrated in Fig. 54 and several succeeding diagrams. These are based on the observations of Van Beneden and Julin made on the rabbit:[1] probably the human amnion develops in a similar manner, but its earliest stages have not been observed, and His has concluded that its origin is not like that in most mammals. The conclusion of His[2] will probably be ultimately found to be erroneous.

At a time shortly before the mesoblastic cleavage or the amniotic folds have commenced, the head end of the embryo sags down, pushing before it the subjacent non-embryonic blastoderm, which here consists of the three typical layers. The blastodermic bag which thus comes to partially envelop the head is known as the *pro-amnion*, and it still persists for some time after the formation of the amniotic folds has commenced (*pr.a*, Fig. 54). It is subsequently obliterated.

In the bird the first mesoblastic cleft and the first amniotic fold occur at the head end of the embryo. In the mammal the reverse is the case: when the amniotic tail-fold (Fig. 54, *a.t.f*) is well developed and the pleuroperitoneal cavity and the primitive amniotic cavity (*amc*) are conspicuous in the tail region, there is a mere trace of a pleuroperitoneal cavity in front of the head, and a very rudimentary head-fold of the amnion (*ahf*).

Moreover, in the chick (Fig. 40) both layers of the amniotic folds contain mesoblast and epiblast; in the mammal only the inner layer, which is to form the true amnion, possesses any mesoblast.

At a somewhat later stage (Fig. 55) the true amnion is completed over the back of the embryo, and the mesoblastic cleft (*amc.p*) has extended back through that portion of the blastoderm which originally formed the pro-amnion. The false amnion is also seen to have separated to a considerable extent from the blastodermic vesicle, which has become reduced in size and covered more than halfway round by mesoblast. Still later (Fig. 56), the false amnion (*fa*) is seen to have become entirely free from the embryo and the blastodermic vesicle, and to have come into contact and fused with the zona pellucida. It is henceforth known as the *subzonal membrane*, and, as the diagrams show, is at all parts composed of epiblast only.

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[1] *Arch. de Biologie*, t. v. p. 369.

[2] *Anatomie Menschlicher Embryonen.*

FIG. 54.

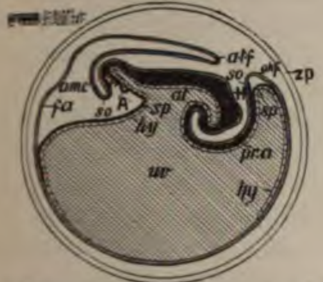

FIG. 55.

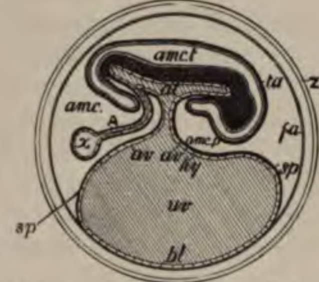

FIG. 54.—Diagram Illustrating Formation of the Fœtal Appendages in a Mammal: H, head of embryo; *pr.a*, pro-amnion; *pp*, tail portion of pleuroperitoneal cavity; *amc*, tail portion of primitive amniotic cavity; *a.t.f*, tail-fold of amnion; *ahf*, head-fold of amnion; *so*, somatopleure; *sp*, splanchnopleure; *fa*, false amnion, consisting only of epiblast; *hy*, hypoblast; *al*, alimentary canal, still communicating freely below with the cavity, *ur*, of the blastodermic vesicle, which will ultimately become the cavity of the yelk-sac, or, as it is named in mammals, the *umbilical vesicle*; *zp*, zona pellucida; A, allantois.

FIG. 55.—Diagram of a Fœtal Mammal, at a more advanced stage than represented in Fig. 54. The amniotic folds have united over the back of the embryo; the false amnion (*fa*) has been separated except at the lower side of the blastodermic vesicle (*bl*): *ta*, true amnion; *amc.t*, cavity of true amnion; *amc*, *amc.p*, cavity of primitive amnion continuous with pleuroperitoneal cavity of body of embryo; *al*, alimentary canal; *ur*, umbilical vesicle or yelk-sac, not yet quite separated from the false amnion below, or entirely surrounded by mesoblast; *sp*, splanchnopleure of umbilical vesicle, consisting of hypoblast and mesoblast, and continuous above with the splanchnopleure of the alimentary canal; *hy*, hypoblast; *av*, thickened region of mesoblast of umbilical vesicle, in which extra-embryonic blood-vessels subsequently arise and form the *area vasculosa*; A, allantois; *x*, the vesicular dilatation at its termination.

*The Amniotic Fluid*, enclosed within the true amnion, varies much in amount in different stages of pregnancy. Its average quantity at the time of parturition of the human fœtus is about 680 cubic centimeters. It is probably a serous liquid transuded from the blood-vessels of the mother, and not, as has been maintained, an excretion from the embryo.[1]

The amniotic liquid protects the embryo from mechanical injury by sudden blows, assists in maintaining a uniform temperature around it, and gives opportunity to the fœtus to make intra-uterine movements.

*The Umbilical Vesicle*, as the mammalian yelk-sac is named, is formed, as in the bird (see Fig. 41), by the infolding of the embryonic splanchnopleure to enclose the alimentary canal, and then its divergence to spread over the non-embryonic region; and by the separation of the false amnion from the rest of the non-embryonic blastoderm. At first (*uv*, Fig. 54) it communicates by a wide opening with the primitive alimentary tube, and is but partially surrounded by hypoblast, and only to a small extent by mesoblast. Somewhat later (Fig. 55) its cavity is found to have diminished, its communication with the alimentary canal to have narrowed so as to form a short stalk, the hypoblast to have grown all around it, and the mesoblast more than halfway. The mesoblast of the developing umbilical vesicle just beyond its stalk now becomes thicker than elsewhere, and numerous blood-vessels arise in it and establish communications along the stalk with arteries and veins which have by this time appeared in the embryo. This highly vascular region of the umbilical vesicle is known as the *area vasculosa*. This area never attains any great importance in the mammal, and soon loses its blood-vessels: in birds it ultimately extends over nearly the whole of the large yelk-sac, and serves to transmit food from the white and yelk to the embryo.

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[1] Minot: *Reference Handbook of Medical Sciences*, vol. i. p. 141.

As development proceeds the false amnion completely separates from the umbilical vesicle and the mesoblastic layer completely surrounds the latter (Fig. 56). The vesicle rapidly diminishes in size, and its stalk, now known as the *umbilical duct*, becomes longer and narrower, though it still remains pervious for some time, affording a direct channel of communication, lined by hypoblast and covered by mesoblast, between

FIG. 56.

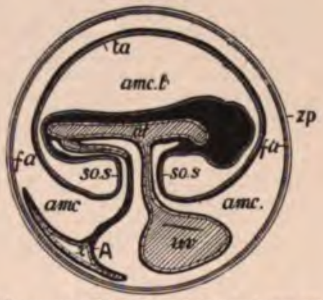


Diagram to illustrate the Development of the Fœtal Appendages of a Mammal, at a later stage than shown in Fig. 55. The true amnion is now much distended by the accumulation within it of amniotic liquid, and its proximal portion, *so.s*, continuous with the infolding body-walls of the embryo, has grown down for some distance around the umbilical duct and allantois, forming a sort of sheath (*so.s*) for them: *fa*, false amnion, or subzonal membrane, now attached to the inner surface of the zona pellucida, *zp*, and having no attachment to any part of the embryo or umbilical vesicle; *ta*, true amnion; *amc.t*, cavity of true amnion; *amc*, cavity of primitive amnion, continuous with pleuroperitoneal cavity of embryo; *al*, alimentary canal; *uv*, umbilical vesicle, connected by the long narrow umbilical duct with the alimentary canal; A, allantois, commencing to spread out beneath the subzonal membrane; *x*, cavity of allantoic vesicle, lined by hypoblast. The stalk of the allantois is seen to be still hollow above and to communicate with the alimentary canal.

the alimentary canal (now nearly closed in below) and the cavity of the umbilical vesicle. At a still later stage (Fig. 57) the umbilical duct is found to have become solid, though still containing a core of hypoblast cells; and the vesicle to have dwindled to a mere remnant: the alimentary tube is entirely closed in by the convergence and fusion of the splanchnopleure folds at the upper end of the umbilical duct. The portion of the intestinal tube to which the umbilical duct is attached becomes ultimately the ileum.

In the human embryo the period during which the umbilical vesicle increases in size ends at about the sixth week: then its rapid diminution commences. Traces of it may, however, be found at birth.

*The Allantois* is an extremely important fœtal appendage, which co-operates with the subzonal membrane and the uterine mucous membrane to form the placenta. It is from the morphological standpoint a special development of the urinary bladder existing in all vertebrates higher than amphibia during fœtal life, and used either to aërate the blood of the embryo (reptiles, birds) or, in addition (mammals), to provide it with nourishment and carry off other wastes as well as carbon dioxide. Though well developed in the chick, giving rise to a highly vascular membrane which lies close to the shell and serves to aërate the blood of the embryo, we did not describe it in the bird, as the ultimate differences between the avian and the mammalian allantois are so great that the history of the development of one does not aid much in understanding that of the other.

The allantois commences (A, Fig. 54) as a tubular outgrowth from the hinder end of the primitive alimentary canal. This outgrowth is lined by hypoblast and covered by mesoblast. As the splanchnopleure folds-in at the tail region of the embryo, closing the hinder part of the body-cavity, the allantois (Fig. 55) grows rapidly forward as a narrow tube to near the stalk of the umbilical vesicle: there it turns away from the embryo and grows into a long hollow stalk, which dilates at its end into a vesicle, *x*. At a somewhat later stage (Fig. 56) most of the stalk of the allantois is found to have become solid, though microscopic examination shows some hypoblastic cells (not indicated in the diagram) all along it. Its terminal vesicle, *x*, is found to have reached the inner side of the subzonal membrane, and to have commenced to flatten out against it. Still later (Fig. 57), the allantoic stalk is longer and relatively narrower, the cavity of the vesicle has disappeared, and the mesoblast of the allantois has spread on every side all around the embryo as a lining to the subzonal membrane, to which it adheres intimately.

The proximal end of the allantois does not become solid: it dilates (*o*, Fig. 57), and, losing later its connection with the alimentary canal and making a separate opening on the exterior, it receives the ureters (p. 194) and becomes the urinary bladder. When the somatopleure folds of the embryo meet at the navel and close-in the body-cavity, a part of the allantoic stalk, reaching from the bladder to the navel, is enclosed in that cavity: it forms the *urachus*, or, in the adult, the *ligamentum vesicæ medium*. The details of allantoic development differ considerably in various mammals: the foregoing description applies to the human embryo.

FIG. 57.

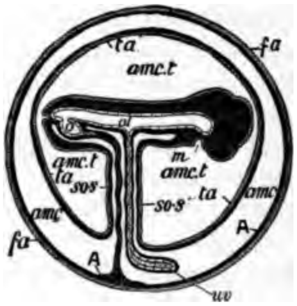


**Diagram of a Human Embryo when the allantois has spread all over the interior of the subzonal membrane:** *fa*, subzonal membrane; A. allantois; *o*, proximal dilatation of the allantois which will ultimately form the urinary bladder; *ta*, true amnion, *amc.t*, cavity of true amnion: *so.s*, downward extension of true amnion, forming the somatopleuric stalk of the umbilical cord; *amc*, primitive amniotic cavity, still continuous through the umbilical cord with the pleuroperitoneal cavity: *m*, commencing involution of the buccal cavity: a similar involution at the tail end indicates the beginning of the anal opening; *uv*, remnant of umbilical vesicle. The zona pellucida has either been absorbed or has so fused with the subzonal membrane as to be indistinguishable.

Blood-vessels very soon develop in the mesoblast of the allantois, and blood is brought to them by a pair of *umbilical* or *allantoic arteries*, which are given off from the terminal bifurcation of the aorta (p. 175). This blood is returned to the embryo at first by a pair of large umbilical veins, one of which, however, soon dwindles away.

*The Umbilical Cord* is a complex structure attached to the ventral surface of the embryo: as shown in an early stage of its development in Fig. 57, it is short and wide, and consists of (1), externally, a sheath of somatopleure formed by a downgrowth of the amnion, and known as the somatic stalk; (2) the narrow remnant of the umbilical duct continuous with the splanchnopleure of the embryo, and known as the splanchnopleuric stalk; and (3) the extra-embryonic portion of the stalk of the allantois. A cross-section of the cord in this stage is diagrammatically represented in Fig. 58.

As development progresses the umbilical cord becomes relatively longer and narrower (Fig. 60). The somatopleures, folding in more and more until they meet at the navel and close-in the cœlome, carry the somatopleuric stalk with them until it ultimately comes into contact with the stalks of the umbilical vesicle and yelk-sac, and all fuse together to make one solid cord traversed by the allantoic blood-vessels, of which the arteries wind in a spiral manner round the veins. The mesoblast of the somatic stalk becomes converted into *jelly-like connective tissue* (*jelly of Wharton*), and binds all the rest together. A cross-section of the cord in this stage is represented in Fig. 59.

From the structure and attachments of the umbilical cord it will be obvious that when it is severed at the navel at birth, the true amnion (previously ruptured by the embryo during parturition) will remain attached to it, as also the allantois and whatever (placental) structures may have developed in connection with that organ, and that the remnant of the umbilical vesicle and ducts will be included in it. All these parts are, in fact, normally expelled together in one mass, the *after-birth*.

FIG. 58.

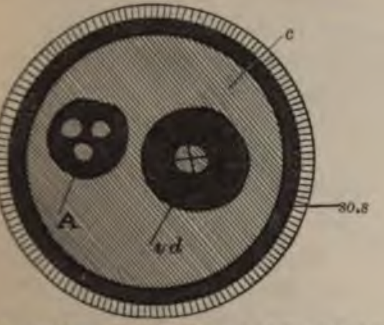


FIG. 59.

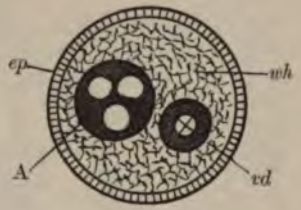


FIG. 58.—Diagram of Cross-section of Umbilical Cord at an early stage of its development: *so.s*, somatopleuric stalk derived from amnion, and consisting externally of epiblast and internally of mesoblast; *vd*, umbilical duct or splanchnopleuric stalk, composed of mesoblast with a hypoblastic core; A, stalk of allantois, mesoblastic, and showing the two allantoic arteries and the allantoic vein in cross-section; *c*, cavity of umbilical cord.

FIG. 59.—Diagram of Cross-section of Umbilical Cord after all its elements have come together and the jelly of Wharton (*wh*) has been developed from the amniotic mesoblast; *ep*, epiblast of amniotic stalk; A, allantoic stalk; *vd*, umbilical duct.

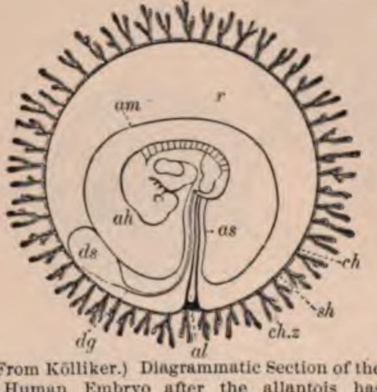
*The Chorion* differs much in various groups of the higher mammals: the following statements apply to the human race and the higher apes.

The primitive ovum has three coats (p. 74): the true vitelline membrane outside; next, the zona pellucida; and internally, a third indistinct layer. The outer and inner coats disappear before or soon after impregnation, but the zona pellucida remains distinct for some time (Figs. 54, 55, 56). It gradually thins away, however, and, soon after the subzonal membrane comes in contact with it, disappears (Fig. 57). The allantois quickly lines the whole subzonal membrane, and, fusing with it, forms a double coat enveloping the whole embryo: the outer layer of this coat is epiblastic and non-vascular and derived from the subzonal membrane; the inner layer is mesoblastic, vascular, and derived from the allantois. This double coat is the *chorion*.

The embryo at this stage has been for some time in the uterus, and, as it enlarges and the amnion becomes distended with liquid, comes to nearly fill the cavity of that organ: folds of the mucous membrane of the womb grow up over it and closely invest it.

About the fourth week the chorion is completed, and immediately large branched villi grow out all over its surface (Fig. 60), and imbed themselves in crypts or depressions which form in the uterine mucous membrane. These crypts are new formations and have nothing to do with the uterine glands.[1] Each of these villi has a vascular core of mesoblast derived from the allantois, and a covering of epithelium derived from the subzonal membrane.

Fig. 60.



(From Kölliker.) Diagrammatic Section of the Human Embryo after the allantois has spread all over the inside of the subzonal membrane, forming the true chorion, from which large branched villi are seen to radiate: *r*, cavity of false amnion or primitive amniotic cavity; *am*, true amnion; *as*, amniotic or somatopleuric stalk of umbilical cord; *ah*, cavity of true amnion; *ds*, umbilical vesicle; *dg*, umbilical duct; *al*, stalk of allantois; *ch.z*, chorionic villi; *sh*, subzonal membrane; *ch*, allantois lining subzonal membrane.

At the time when the chorionic villi appear three regions may be distinguished in the uterine mucous membrane. Parts of each are cast off with the after-birth, hence they are named decidua. They are represented at a little later stage in Fig. 61. To quote from Balfour:[2]

"There is (1) the part of the [mucous membrane] reflected over the [embryo and its appendages], called the *decidua reflexa, dr;* (2) the part of the [uterine mucous membrane] forming the area round which the reflexa is inserted, called the *decidua serotina, ds;* the general wall of the uterus not related to the embryo, called the *decidua vera, dv.*"

"The decidua reflexa and serotina together envelop the chorion, the processes of which fit into crypts in them. At this period both of them are highly and nearly uniformly vascular. The general cavity of the uterus is to a large extent obliterated by the [embryo and its appendages], but still persists as a space filled with mucus between the decidua reflexa and decidua vera.

"The amnion (*am*) continues to dilate (its cavity being tensely filled with amniotic fluid) until it comes very close to the chorion; from which, however, it remains separated by a layer of gelatinous tissue. The villi of the chorion in the region covered by the decidua reflexa gradually cease to be vascular, and partially atrophy, but in the region in contact with the decidua serotina increase and become more vascular and more arborescent (Fig. 61, *z*). The former region becomes known as the *chorion lœve*, and the latter as the *chorion frondosum*. The chorion frondosum, together with the decidua serotina, gives rise to the placenta. That part of the chorion which helps to form the placenta is distinguished as the *true chorion* from the remainder or *false chorion*.

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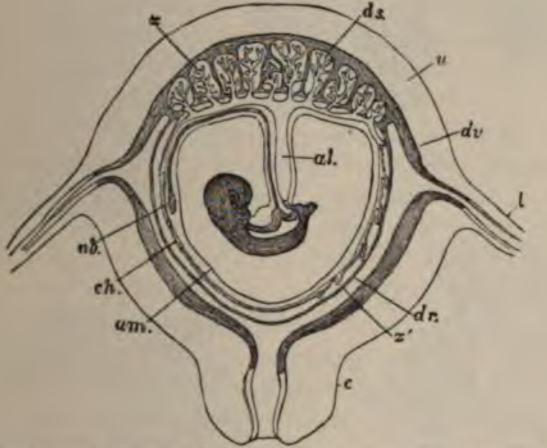
[1] In many mammals smaller and simpler villi grow out from the zona pellucida or subzonal membrane before the chorion is completed. According to Allen Thomson and Reichert, such villi are to be found on the human embryo a fortnight after impregnation; they soon give way to the true chorionic villi.

[2] *Comparative Embryology*, vol. ii. p. 203.

Fig. 61.

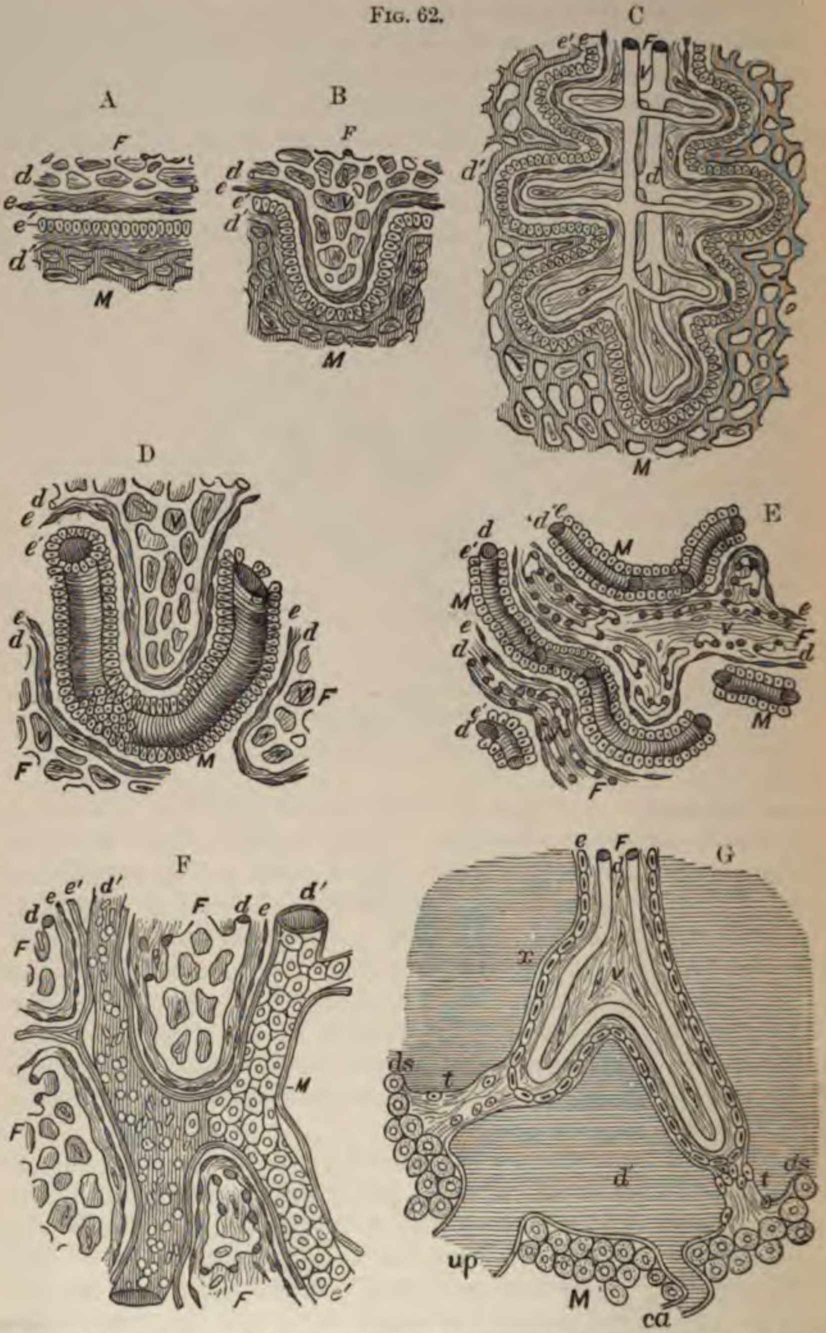


(From Huxley, after Longet.) Diagrammatic Section of Pregnant Human Uterus, with contained fœtus: *al*, allantoic stalk; *uv*, umbilical vesicle; *am*, amnion; *ch*, chorion; *ds*, decidua serotina; *dv*, decidua vera; *dr*, decidua reflexa; *l*, Fallopian tube; *c*, cervix uteri; *u*, uterus; *z*, fœtal villi of placenta; *z'*, villi of non-placental part of chorion.

"Although the vascular supply is cut off from the chorion læve, the processes on its surfaces do not completely abort. It becomes, as the time of birth approaches, more and more closely united with the reflexa, till the union between the two is so close that their exact boundaries cannot be made out. The umbilical vesicle (*uv*), although it becomes greatly reduced in size and flattened, persists in a recognizable form till the time of birth.

"As the embryo enlarges the space between the decidua vera and decidua reflexa becomes reduced, and finally the two parts unite. . . . . During the whole of pregnancy the decidua vera can, however, be distinguished by its structure, and remains highly vascular. The decidua reflexa becomes non-vascular, and fuses, as has been stated, on one side with the chorion and on the other with the vera. The membrane resulting from its fusion with the latter becomes thinner and thinner as pregnancy advances, and is reduced to a thin layer at the time of birth."

FIG. 62.



(From Balfour, after Turner.) A, placenta in its most generalized form; B, structure of placenta of pig; C, structure of placenta of cow; D, structure of placenta of fox; E, structure of placenta of cat; F, structure of placenta of sloth: on the right side of the figure the flat maternal epithelial cells are shown *in situ*: on the left side they are removed, and the dilated

*The Placenta.*—The human placenta is so highly specialized a structure that to understand it requires some previous study of simpler forms of the organ.

The placentæ of the higher mammals fall into two great groups—*deciduate* and *non-deciduate.* In the deciduate type the connection between the fœtal and maternal structures is so close that part of the uterine mucous membrane comes away with the after-birth; this is not the case in non-deciduate forms. There are several subsidiary varieties of both these main kinds of placentæ, known from their shape and arrangement as discoidal, zonary, diffuse, and so forth, but into the description of most of these we need not enter.

The placenta in all the higher mammals is, as we have seen, a compound organ, composed partly of fœtal structures (true chorion) and partly of maternal structures (decidua serotina). The function of the organ is to bring the fœtal blood into such close relationship with the maternal that the former may by diffusion give up its wastes to the blood of the mother, and receive similarly from that blood food and oxygen. There is in no case any actual mixing of the two bloods, the fœtal and maternal blood-vessels remaining quite distinct throughout.

The simplest conceivable form of placenta is indicated at A, Fig. 62, where *F* represents the fœtal, and *M* the maternal, portion; both are flat membranes closely applied: *d* represents the allantoic part of the chorion with its capillaries, and *e* the subzonal layer of the chorion reduced to a stratum of flattened cells. In the maternal part *e′* indicates the lining epithelium of the uterus, and *d′* the vascular corium of the uterine mucous membrane with its capillaries. In such a structure dialysis could take place through the two epithelial layers, between the bloods in the fœtal and maternal vessels. Such a placenta would, however, afford but a comparatively small area for the interchange of materials; and none so simple is known.

If, however, the uterine surface became pouched, and the chorionic surface sent outgrowths into these pouches, the superficial area of contact of the two parts of the placenta would be greatly increased. The simplest known stage of this process is found in the pig (B, Fig. 62). The uterus of the sow develops a number of shallow crypts into which simple villi from the chorion grow.

The next stage in evolution may be illustrated by the placenta of the

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maternal vessel [illegible] f human placenta [illegible] fœtal, and M, maternal placenta [illegible] epithelium of maternal placenta [illegible]

The succeeding [illegible] placenta; [illegible] serotina passing [illegible] vein; [illegible] layer, c, which [illegible] delicate connective [illegible] belonging to [illegible] maternal cells derived [illegible] of the [illegible] human placenta.

cow (C, Fig. 62), in which the uterine crypts and the chorionic villi have both become branched, thus affording a more extensive surface for the diffusion processes between the bloods of the embryo and the mother.

The placentas of the pig and cow are non-deciduate, and two layers of epithelium (one fœtal and one maternal) separate the allantoic and uterine vessels. The maternal vessels are in both cases capillaries.

In deciduate placentas a further advance is made. In the fox and cat (D, E, Fig. 62) the maternal capillaries become greatly dilated, and, covered by a little connective tissue and by a layer of uterine epithelium, *e′*, form an anastomosing network within which the fœtal villi twine. The surface for mutual diffusion is thus greatly increased.

In the sloth (F, Fig. 62) the maternal capillaries are still more dilated, and the epithelium covering them has become flattened instead of columnar, so that a still thinner membrane is interposed between the bloods of embryo and mother.

In the human placenta (G, Fig. 62) and in that of apes we find a higher evolution. The maternal vessels dilate into large sinuses, *d′*, which freely intercommunicate. Blood is conveyed abundantly to these sinuses by enlarged uterine arteries, and carried off from them by the dilated veins of the pregnant womb. The branched fœtal villi of the true chorion project into these sinuses, and, bathed on every side by the flowing maternal blood, for the most part hang freely within them. The villi are, however, sometimes attached by cords (*t*) to the walls of the sinus. In the later stages of embryonic life there is only one layer of epithelium between the maternal and the fœtal blood. This closely invests the fœtal villi, but is derived from the uterus, the original subzonal epithelium of the chorion having disappeared.

*The human placenta,* when fully developed, is a discoid[1] organ, slightly convex on its outer and concave on its inner surface. It develops normally on the ventral side of the embryo, and, so far as its fœtal portion is concerned, from that region of the allantois which lies in the neighborhood of the allantoic stalk. It is usually circular or oval in outline, and varies considerably in size. A full-sized oval placenta measures 7–7½ inches (17.8–19 centimeters) in its shorter and 8–9½ inches (20.5–24.0 centimeters) in its longer diameter. The thickness is generally greatest opposite the point of entrance of the umbilical or allantoic stalk, where the organ measures 1–1¼ inches (2.5–3.2 centimeters); it becomes gradually attenuated toward the margin, which is slightly rounded, measuring here only 2–4 lines (4–7 millimeters) in thickness (Farre). At its margins it is continuous with both the decidua vera and the decidua reflexa (Figs. 61 and 64).

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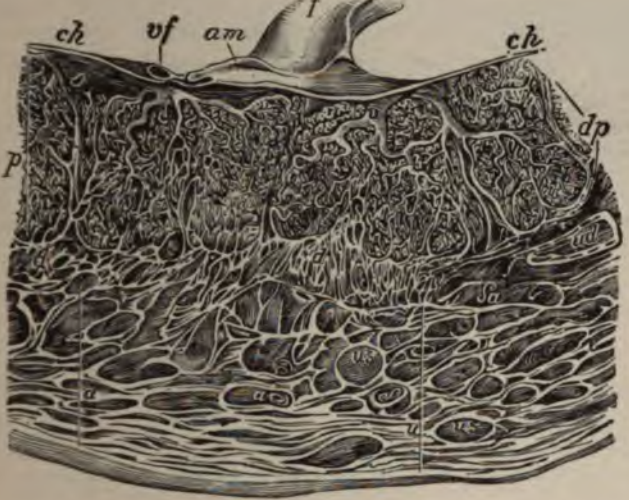
[1] The placenta of Rodentia, Insectivora, and Cheiroptera is also discoidal in form, but differs in several important respects, as regards development, from that of man and apes. Comparative embryologists reserve the name discoidal for the rodent type, and name the human type meta-discoidal. (See Foster and Balfour, *Elements of Embryology*, p. 353 *et seq.*)

The amniotic sheath of the umbilical cord is shown in Figs. 57 and 60 as having extended a considerable distance along the allantoic stalk, but as not yet having reached the inner surface of the chorion. This it ultimately does, and the amnion then spreads out on all sides over the chorion frondosum, and, adhering closely to it, forms the inner or foetal surface of the placenta. At the margins of the placenta it turns back to envelop the embryo. A section through the placenta (Fig. 63) therefore shows the amnion (*am*) as forming its innermost layer,

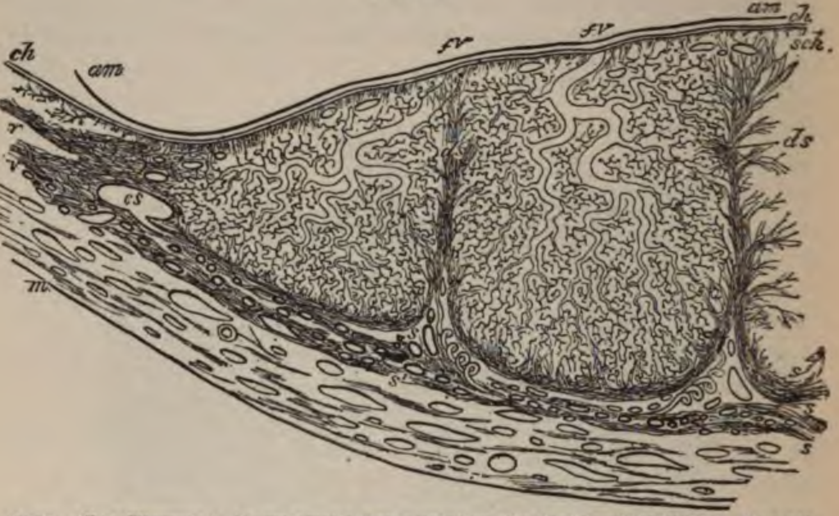
Fig. 63.



Vertical Section of Uterus, with placenta attached (from a woman in the thirtieth week of gestation; from Farre, after Wagner). The lines *uu* indicate the thickness of the uterine wall outside the decidua serotina; *dp*, the decidua serotina, or placenta; *p*, the thickness of the rest of the placenta (toward the right of the figure the serotina is separated into *ud*, uterine serotina, and *dp*, decidual serotina, with its septa passing up among the chorionic villi); *f*, umbilical cord; *am*, amnion; *ch*, chorion; *vf*, fœtal blood-vessel on surface of placenta cut across; *vv*, chorionic villi; *us* and *a*, dilated uterine blood-vessels.

Immediately external to the amniotic layer comes the chorion (*ch*), from whose outer surface the very numerous, greatly-branched, tortuous villi (*v*) project: these villi soon lose their proper epithelium derived from the subzonal membrane (p. 132); the structure of their terminal branches has been shown in G, Fig. 62. The allantoic arteries reaching the chorionic layer through the umbilical cord (*f*) ramify in this layer in the form of a number of large branches which spread over it just beneath the amnion: one of these branches is represented cut across at *vf*. The terminal branches of the arteries when they have become reduced to the size of a crowquill suddenly dip down from the surface and enter the villous layer. The larger trunks also, as they diverge, give off branches from their deeper sides which supply the villi. The veins, returning the fœtal blood, have a course similar to the arteries: the larger trunks converge toward the funis, and there enter the umbilical (allantoic) vein.[1] In the villi the arteries and veins are connected by a capillary network.

Fig. 64.



(From Allen Thomson.) Diagrammatic Representation of a Section of the Human Placenta, near the margin, at five or six months: *am*, amnion; *ch*, chorion: from its under surface the branched villi are seen to project; *m*, muscular coat of uterus with divided blood-vessels; *v*, decidua vera; *r*, decidua reflexa; *s*, placental serotina; *s'*, uterine serotina; *ds*, septa of placental serotina separating the lobes of the placenta: near their bases are seen the coiled arteries; *cs*, circular sinus, a great vein which runs around the margin of the placenta.

The amniotic layer and the chorionic layer, with the villi and blood-vessels of the latter, constitute the fœtal portion of the placenta.

Soon after the chorion frondosum comes in contact with the decidua serotina the inner stratum of the latter becomes greatly modified. It loses its lining epithelium, and the superficial portions of the uterine glands previously contained in it disappear.[2] This layer of the serotina thus becomes a mere vascular fibrous membrane. The lower ends of the glands still remain intact in the deeper layer of the serotina (*ud*, Fig. 63). During parturition the superficial non-glandular serotina is shed as a part of the placenta, while the deeper glandular layer remains to renew the uterine lining, the new epithelium spreading out from the mouths of the glands much as after an ordinary menstruation (p. 84). That portion of the serotina which is intimately associated with the fœtal structures, and is shed with them, is distinguished as the *placental* from the other or *uterine* layer. Toward the right of Fig. 63 these two layers are indicated as *dp* and *up* respectively, but they are more clearly shown in the diagram, Fig. 64.

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[1] For a more detailed description of the arteries and veins of the placenta see Farre in *Todd's Cyclopædia*, supplementary volume, p. 716.

[2] If, as is probable, Pflüger's theory of menstruation (p. 94) be correct, the epithelium and the superficial portions of the glands are shed before the embryo reaches the uterus.

When the placenta is detached after a normal labor its outer surface is seen to consist of a thin, soft, tough layer marked out by furrows into numerous oval or angular areas varying from half an inch to an inch and a half in diameter. From the boundaries between these areas septa of connective tissue (*dp*, Fig. 63, and *ds*, Fig. 64) pass into the villous stratum of the placenta and subdivide it into numerous lobes or *cotyledons*. From the sides of the septa connective-tissue cords ramify and intertwine with, support, and in many places adhere to the chorionic villi. The surfaces of the cords and villi are everywhere covered by a single layer of epithelium cells.

The substance of the placenta, from the chorion inside to the placental serotina outside, is thus a loose, spongy mass, traversed in all directions by chorionic villi and by bands of connective tissue; and the cavities of the sponge are everywhere lined by an epithelium. These cavities are the *blood-sinuses* through which the maternal blood flows to bathe the fœtal villi (p. 136). The uterine arteries (*a*, Fig. 63) outside the decidua enlarge while the placenta is developing, and become somewhat twisted. Passing in, they branch in the uterine serotina, and then enter the placental serotina, and, becoming spirally coiled (see Fig. 64), enter its septa. Branching somewhat in these septa, the arteries finally open into the blood-sinuses, their epithelium being continuous with, and passing into, those lining the sinuses: the latter are, in fact, enormously-dilated capillaries closely investing the fœtal villi on all sides, one capillary wall, represented by the cells *e′* (G, Fig. 62), adhering to each villus.

From the sinuses the blood is collected directly by veins which open into them, and is carried away from the womb in the main uterine veins.

When the placental serotina separates from the uterine during parturition the arteries and veins are ruptured at the contact of the two layers; but in normal conditions the contraction of the womb quickly closes them, and no great amount of bleeding results.

The decidua reflexa and decidua vera, which are continuous with the placenta (Fig. 61, 64), are discharged with it as part of the after-birth.[1]

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[1] For details as to the histology of the placenta consult Minot, in the *Reference Handbook of the Medical Sciences*. Minot's description differs from that above given; he believes that the epithelium of the chorionic villi in advanced stages of pregnancy is fœtal and not maternal in origin.

## V. THE DEVELOPMENT OF SOME OF THE MORE IMPORTANT ORGANS AND SYSTEMS.

*The Development of the Spinal Column.*—The notochord arises in the mammal, as in the chick (Figs. 25, 26, 27), from hypoblast cells, and forms a rod separated by a clear space containing only liquid (p. 108) from the peripheral plates of the mesoblast. Its anterior end reaches forward to the region where the body of the sphenoid will be developed later. As the embryo grows by additions to its posterior end, the notochord also elongates; it reaches as far back as the tip of the future coccyx. In Mammalia it is from the first constricted at intervals, each constriction in the vertebral region corresponding in position to the body of a future vertebra.

FIG. 65.

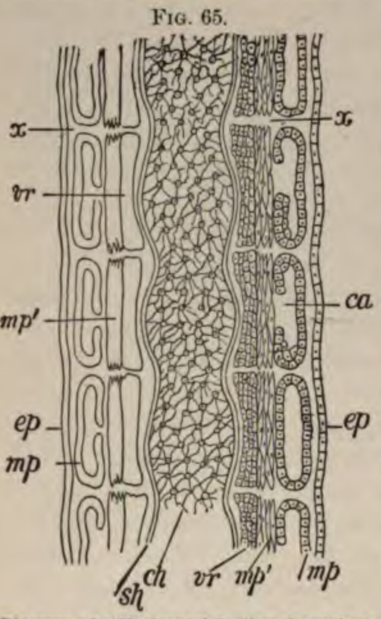
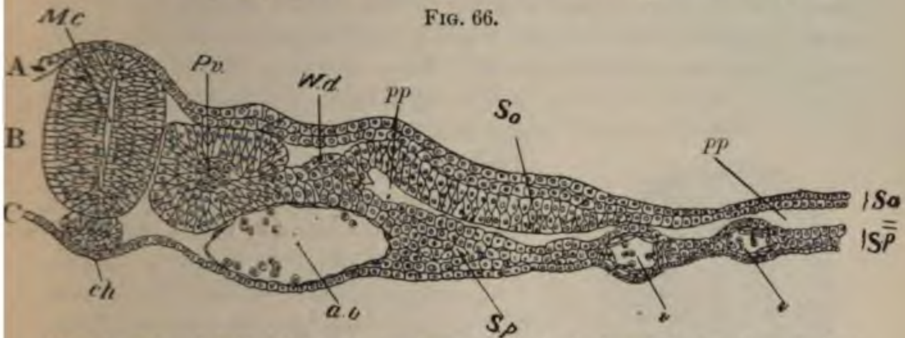


Diagram of a Horizontal Section through an Embryo at the level of the notochord, and after the mesoblastic somites have commenced to differentiate: *ch*, reticular notochord, constricted at points which correspond in position to the centra of the future vertebræ; *sh*, sheath of notochord: *mp*, outer portion of muscle-plate; *ca*, its cavity; *mp′*, inner part of muscle-plate, commencing to form the longitudinal muscles of the trunk; *vr*, inner part of mesoblastic somite which will give rise to the bodies of the vertebræ and the greater portion of the intervertebral disks; *ep*, epiblast on outer surface of embryo.

The notochord cells are at first rounded and solid, but they quickly become greatly vacuolated, and form a spongy reticulum with nuclei scattered here and there throughout it (*ch*, Fig. 65). Around the rod a structureless sheath, *sh*, is excreted by its cells.

The mesoblast, as has been pointed out (p. 107 and Fig. 30), spreads as a peripheral plate from each side of the notochord between the epiblast and hypoblast. When it cleaves into its outer (somatopleuric) and inner (splanchnopleuric) layers the cleavage at first extends close up to its central margin, near the notochord. While the outer part of the cleft widens rapidly to form the pleuroperitoneal and primitive amniotic cavities, the inner part remains narrow (Fig. 36), and, in fact, for a time disappears entirely. The mesoblast then thins away from above down on each side in a line parallel with the notochord (Fig. 66), and nearer to it than the commencing dilation of the pleuroperitoneal cavity, *pp*. There is thus incompletely separated a more mesial solid plate of mesoblast, *Pv*, from a more peripheral cleft-plate: the former is the *vertebral plate*, the latter the *lateral plate*. At this stage the vertebral plate is seen to possess a core of central cells different from those on its outside. The cells above this core are continuous with the somatic layer of the lateral plate, and the cells below it with the splanchnic layer.

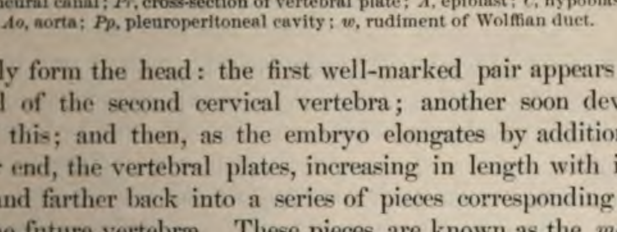
FIG. 66.



(From Foster and Balfour.) Transverse Section through the Dorsal Region of an Embryo (chick) after forty-five hours' incubation: A, epiblast; B, mesoblast; C, hypoblast; *M.c*, neural canal, closed in; *P.v*, cross-section of vertebral plate; *pp*, commencing pleuroperitoneal cavity in lateral plate: between the vertebral and lateral plates the mesoblast is seen to be thinner than elsewhere; *So*, somatopleure; *Sp*, splanchnopleure; *ch*, notochord; *a.o*, one of the dorsal aorta: at this stage there are two in this region of the embryo; *v*, blood-vessels of splanchnopleure; *W.d*, cross-section of Wolffian duct.

Very soon (Fig. 67) the vertebral plate separates entirely from the lateral plate, and forms a rod on each side of the neural canal. This rod almost immediately commences to divide transversely at short intervals, and thus becomes cut up into a number of cuboidal pieces (Figs. 29 and 68), which lie on each side of the neural canal. The cross-divisions do not occur or are indistinct in the region which will ultimately form the head: the first well-marked pair appears at about the level of the second cervical vertebra; another soon develops in front of this; and then, as the embryo elongates by additions to its posterior end, the vertebral plates, increasing in length with it, divide farther and farther back into a series of pieces corresponding in number to the future vertebræ. These pieces are known as the *mesoblastic somites*. Each consists at first of an outer layer of large columnar cells and of a core of smaller rounded cells.

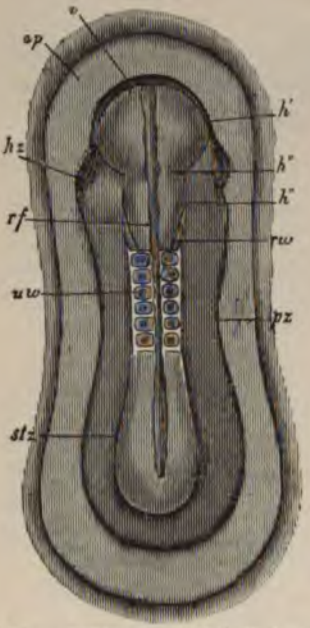
FIG. 67.



(From His.) Cross-section of Dorsal Region of Chick Embryo at a little later stage than Fig. 66: *M*, neural canal; *Pr*, cross-section of vertebral plate; *A*, epiblast; *C*, hypoblast; *Ch*, notochord; *Ao*, aorta; *Pp*, pleuroperitoneal cavity; *w*, rudiment of Wolffian duct.

As the embryo grows and its body-walls fold in more and more, its

FIG. 68.



(From Kölliker.) Rabbit Embryo eight days and fourteen hours after coition, viewed from above and magnified nearly 28 diameters. Six mesoblastic somites have developed: *ap*, area pellucida; *v*, anterior border of head; *h'*, fore-brain; *h''*, region in which mid-brain will develop later; *h'''*, commencement of hind-brain; *uw*, mesoblastic somites.

depth or thickness from the epiblast covering in its dorsal region to the hypoblast on its under surface increases considerably, and the mesoblastic somites grow rapidly. They extend upward around the neural canal, and meet from each side above it, thus separating the canal from contact with the external epiblast. They also grow inward below the neural canal, between it and the notochord and between the latter and the hypoblast. The notochord thus acquires a close investment of mesoblast cells. These changes are indicated in Fig. 69, which should be compared with Figs. 66 and 30. Meantime each mesoblastic somite differentiates into an upper outer portion (*mp*, *mp'*, Figs. 65 and 69), the *muscle-plate*, and an inner or *vertebral portion*, from which the spinal column and its ligaments are ultimately formed.

The original narrow cleft in the mesoblast of each vertebral plate (p. 116), which had become indistinguishable, now reappears (*ca*, Figs. 65 and 69) for a brief time in each muscle-plate. In Fig. 65, which represents a horizontal section through several somites of the embryo at the level of the notochord, it is seen that these cavities lie in a row on each side, one for each somite. The mesoblast cells (*mp'*) on the inner side of the cavity rapidly elongate, and give origin to longitudinal muscle-fibres running the whole length of the neck and trunk of the embryo. These muscles are at first, as is obvious from Fig. 65, segmented, being interrupted at the spaces, *x*, between the somites. This condition is permanent in many of the lower vertebrates (fishes), but is soon obscured in mammals by fusion end to end of the muscles of neighboring somites. The outer portion of the muscle-plate (*mp*, Figs. 65 and 69) also becomes ultimately converted into muscles, and all traces of the original cavity are lost. All the voluntary muscles of the head, neck, and trunk are ultimately developed from extensions of the muscle-plates: probably the same is true of all the skeletal muscles of the body, though it is still uncertain as regards the mammals whether the muscles of the limbs do not arise independently: the origin of the diaphragm is also as yet undetermined.

The vertebral portion of each mesoblastic somite (*vr*, Figs. 65 and 69) when it first envelops the neural canal and notochord is separated by a cleft from the somites in front of and behind it. These interspaces are soon obliterated, and the notochord thus obtains a continuous unsegmented mesoblastic sheath. The cleft separating the vertebral from the lateral plate, which was nearly vertical in an earlier stage (Fig. 67), has by this time (*y*, Fig. 69) become nearly horizontal on account of changes in the relative sizes and positions of different parts of the embryo: this cleft also becomes obliterated at a later stage in development, and the lateral and vertebral plates again become continuous (Fig. 79).

Fig. 69.

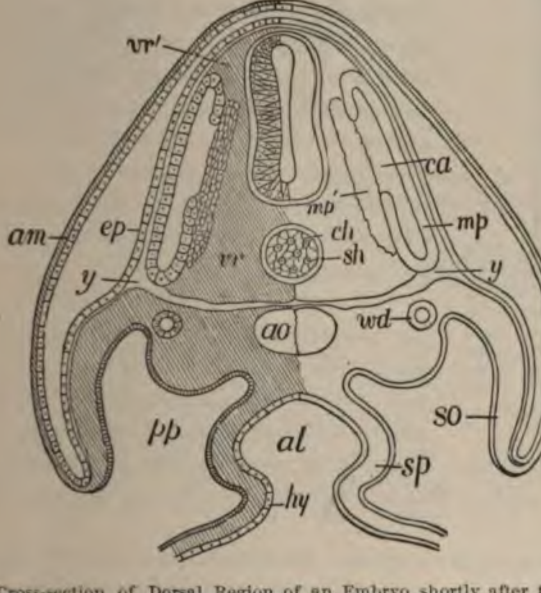
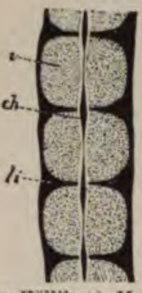


Diagram of Cross-section of Dorsal Region of an Embryo shortly after the differentiation of the muscle-plates (to be studied in connection with the horizontal section, Fig. 65): *mp*, outer layer of muscle-plate; *mp'*, inner layer of muscle-plate, giving origin to longitudinal muscles; *ca*, cavity of muscle-plate; *ch*, notochord; *sh*, sheath of notochord; *vr*, vertebral portion of mesoblastic somite; *vr'*, its upward extension (*neural plate*) to surround the neural canal: the vertebral portion will be seen to have grown to the middle line below and enveloped the notochord; *ep*, epiblast; *hy*, hypoblast; *so*, somatopleure; *sp*, splanchnopleure; *al*, alimentary canal; *pp*, pleuroperitoneal cavity: the mesoblast cells lining it are already developing the epithelium of the future pleural and peritoneal cavities; *wd*, Wolffian duct; *y*, cleft between mesoblastic somite and lateral plate; *am*, true amnion: this is omitted in Fig. 65.

The unsegmented mesoblastic sheath of the notochord through its upper extensions, or *neural plates* (*vr'*, Fig. 69), provides a continuous envelope for the neural canal. This condition gives place to the *secondary segmentation* of the spinal column by which the vertebræ are separated from one another; but the *new segments are opposite the inter-*

*vals between the former.*[1] The mesoblast immediately around the notochord becomes cartilaginous at intervals, and forms a number of nodules which encroach on and constrict the notochord (Fig. 70). Each nodule arises opposite one of the division lines ($x$, Fig. 65) between the original somites, and is the rudiment of the centrum of a vertebra. The tissue between the nodules becomes fibrous and forms ultimately an intervertebral disk. Almost simultaneously the neural plates ($vr'$, Fig. 69) become cartilaginous at intervals corresponding to the rudiments of the vertebral bodies; and these cartilages, joining the centra below and meeting over the neural canal above, are the rudiments of the neural arches of the vertebræ. The mesoblast of the neural ridge between the neural arches gives origin to the ligaments uniting them; the inner layer of the ridge nowhere becomes cartilaginous, but develops into the perichondrium, periosteum, and dura mater.

FIG. 70.



(From Kölliker.) Magnified Horizontal Longitudinal Section through several Thoracic Vertebræ of a Human Embryo of eight weeks: *v*, cartilaginous vertebral centrum; *li*, intervertebral ligament; *ch*, remnant of notochord.

The modification of mesoblast cells surrounding the notochord into cartilage, occurs about the fourth or fifth week in the human embryo, and the chondrification of the neural arches almost simultaneously. Ossification commences about the eighth week from three centres—one in the body and two in the neural arch. The first vertebra to ossify is the second or third cervical.

When ossification is completed the notochord is entirely obliterated in the vertebral centra, but a modified residue of it may be found throughout life as the *nucleus pulposus* of the intervertebral disk.

It would carry us beyond the limits of the space at our disposal to describe in detail the embryology of the rest of the skeleton. Some account of the origin of the facial skeleton will, however, be given later (p. 185).

*The Development of the Limbs.*—The limbs arise as lateral outgrowths of the mesoblast and epiblast of the somatopleuric layer of the lateral plates at positions which correspond to the future pectoral and pelvic arches. They appear in the human embryo as somewhat flattened outgrowths about the fourth week after conception. If the diagram (Fig. 69) represented a cross-section in the region of the origin of the limbs, they would be indicated as outgrowths of the somatopleure a short way below the line of reference leading from the letter *y*.

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[1] "The explanation of this character in the segmentation is not difficult to find. The primary segmentation of the body is that of the muscle-plates, which were present in the primitive forms in which vertebræ had not appeared. As soon, however, as the notochordal sheath was required to be strong as well as flexible, it necessarily became divided into a series of segments.

"The condition under which the lateral muscles can best cause the flexure of the vertebral column is clearly that each myotome [segment of longitudinal muscle] shall be capable of acting on two vertebræ; and this condition can only be fulfilled when the myotomes are opposite the intervals between the vertebræ" (*Balfour*).

FIG. 71.

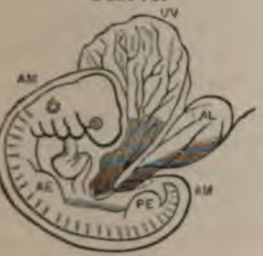


FIG. 72.

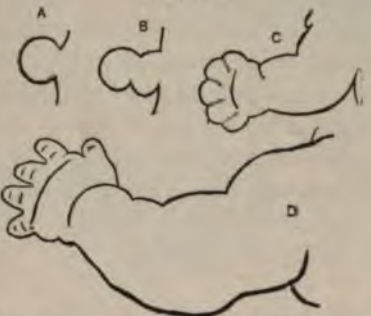
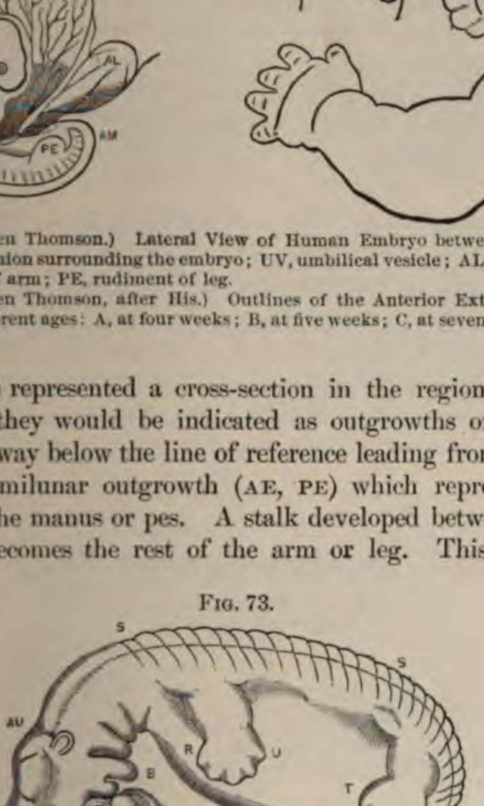


**FIG. 71.**—(From Allen Thomson.) **Lateral View of Human Embryo between three and four weeks**: AM, amnion surrounding the embryo; UV, umbilical vesicle; AL, stalk of allantois; AE, rudiment of arm; PE, rudiment of leg.

**FIG. 72.**—(From Allen Thomson, after His.) **Outlines of the Anterior Extremity of Human Embryos at different ages**: A, at four weeks; B, at five weeks; C, at seven weeks; D, at nine or ten weeks.

The first semilunar outgrowth (AE, PE) which represents a limb develops into the manus or pes. A stalk developed between it and the trunk region becomes the rest of the arm or leg. This stalk is first separated by a constriction from the foot or hand, and later subdivided into *antebrachium* and *brachium*, or *crus* and *femur*. The progress of development in the case of the fore limb is shown in Fig. 72. While the changes which give rise to forearm and arm and crus and thigh are occurring, the first formed and peripheral segment of the limb pre-

FIG. 73.



(From Allen Thomson.) **Diagrammatic Outline of a Human Embryo of about seven weeks, to show the primitive relations of the limbs to the trunk**: R, the radial (pre-axial), and U, the ulnar (post-axial) border of the hand and forearm; T, the tibial (pre-axial), and F, the fibular (post-axial) border of the foot and lower leg.

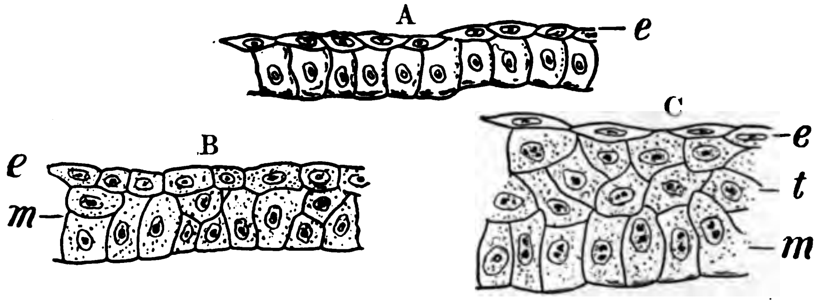
sents four notches (D, Fig. 72), which indicate its subdivision into five digits.

The crescentic outgrowths which are the first rudiments of the limb are thin plates presenting a dorsal and a ventral surface. The dorsal surface corresponds to the future extensor surface of each limb, and the ventral to the flexor, and the thumb and great toe are at first on the forward or pre-axial side (Fig. 73), as are also the radial and tibial bones when they appear: the radius and tibia are therefore *pre-axial* as compared with the embryonic ulna and fibula, which are *post-axial.* The elbow- and knee-joints of the early embryo flex toward the trunk: their subsequent directions of movement are due to a partial rotation of each limb, which results in making the elbow bend ventrally and the knee-joint dorsally.

*The Development of the Skin and its Appendages.*—The skin has a double origin. Its deeper layer, the *cutis vera,* consisting of connective tissue, blood-vessels, and lymphatics, is formed by modification of mesoblast cells lying immediately under the epiblast: its superficial layer, the *cuticle* or *epidermis,* and all hairs, nails, and the secretory cells of cutaneous glands, originate from the embryonic epiblast.

In all the higher vertebrates the external epiblast, which at first consists of a single layer of cells, becomes two-layered (Fig. 74, A): the outer layer, *e*, becomes flattened and forms the *epitrichial layer*, which is shed before birth. Minot[1] has shown that this layer can be found in the human embryo about the fourth month of intra-uterine life. It encloses beneath it the secretion of the embryonic sebaceous glands, and thus causes the accumulation of the vernix caseosa.

Fig. 74.



(From Haddon, after Jeffries.) Sections of Developing Epidermis of Bird Embryos: A, vertical section of chick embryo after one hundred and eleven hours' incubation; B, the same after one hundred and thirty-four hours' incubation; C, section through epidermis of duck after seventeen days of incubation; *e*, epitrichial layer: *m*, Malpighian layer; *t*, transitional layer.

After the epitrichial layer has been formed, the deeper cells of the epiblast multiply and form an epidermis several layers of cells in thickness. The superficial cells, becoming horny and dead (*stratum corneum*, Fig. 75), are shed throughout life, while the deeper cells multiply and replace them: the deeper-placed living epidermic cells constitute the so-called *Malpighian* or *mucous layer*, *SM*. A true horny layer of the epidermis develops only in terrestrial vertebrates.

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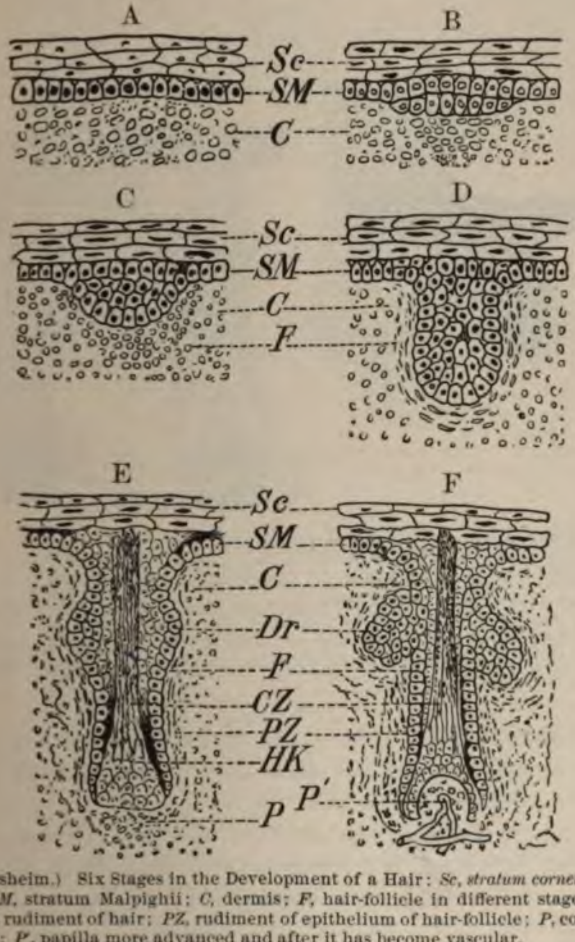
[1] *American Naturalist,* 1886.

FIG. 75.

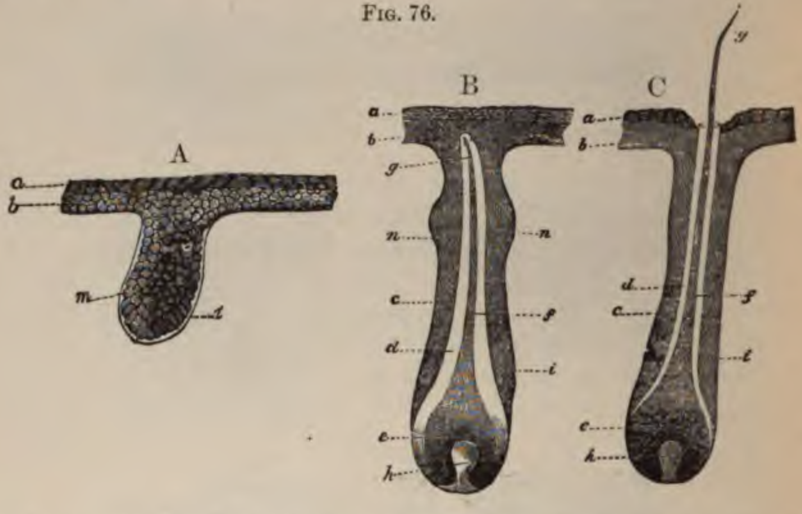


(From Wiedersheim.) Six Stages in the Development of a Hair: *Sc*, *stratum corneum* of the epidermis; *SM*, stratum Malpighii; *C*, dermis; *F*, hair-follicle in different stages of development; *CZ*, rudiment of hair; *PZ*, rudiment of epithelium of hair-follicle; *P*, commencement of papilla; *P′*, papilla more advanced and after it has become vascular.

*Hairs.*—Every hair commences as an ingrowth of the Malpighian layer of the epidermis, reaching down into the dermis as a solid rod of cells. This rod dilates at its deeper end (E, Fig. 75), and then a vascular dermic papilla extends into it (F). Meanwhile, the primitive continuous cylinder (D) of epidermic cells divides concentrically into an inner core and an outer epidermic sheath (E, F). The cells of the core form the hair, which ultimately breaks through the horny layer of the epidermis and projects beyond it (Fig. 76). The cells of the sheath give origin to the lining of the hair-follicle. For the final structure of this and of the hair a treatise on histology must be consulted.

The first rudiments of hairs may be detected toward the close of the third month in the human embryo. They break through the horny layer of the epidermis (Fig. 76) during the fifth month of intra-uterine life: the hairs of this first crop (*lanugo*) are for the most part shed before birth, and may be found floating in the amniotic liquid and imbedded in the *vernix caseosa*.

FIG. 76.



(From Kölliker.) Developing Hair of Eyebrow, magnified fifty diameters. In A: *a*, horny layer of epidermis; *b*, Malpighian layer of epidermis; *m*, commencing hair.
In B, the letters of reference as before: in addition, *c*, cells which will form the external root sheath; *i*, limiting membrane; *h*, dermic papilla; *e*, swollen lower end of hair-rudiment *f*, stem, and *g* apex, of future hair; *n*, *n*, commencing sebaceous glands.
In C, the hair represented just after it has burst through the horny layer of the epidermis and protruded from its follicle.

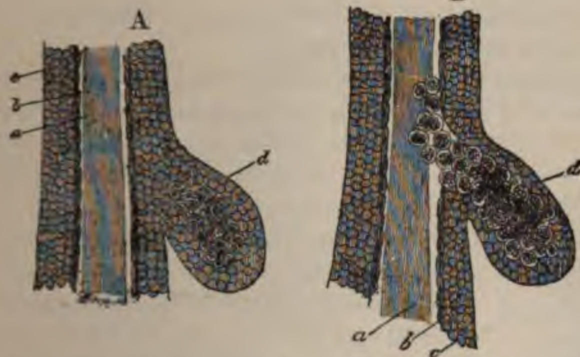
According to Kölliker, all the hairs of a newborn infant are shed and replaced during the first few months of extra-uterine life, those of the general surface being first cast off, and later (about twelve months after birth) those of the scalp and the eyelashes.

*The Sweat-glands* at their origin are at first much like rudimentary hairs: they consist of a cylinder of cells from the Malpighian layer of the epidermis which burrows down into the dermis, and becomes there twisted and expanded at its deeper end. Around the epidermic cylinder the dermis forms connective tissue and blood-vessels, and the rod of epidermic cells becomes hollow, forming the lumen of the gland. At first the glands are closed externally by the horny layer of the epidermis, but they subsequently open through it.

The ceruminous glands of the external auditory meatus are, judging from their development in the embryo, only modified sweat-glands.

*The Sebaceous Glands* almost invariably arise as outgrowths from the epidermic layer of the root-sheath of a hair (*Dr*, Fig. 75). At a somewhat later stage (Fig. 77) each is seen to form a flask-shaped appendage to a hair-follicle. The central cells of this appendage undergo fatty degeneration, and this extends along the axis of the neck of the gland. Ultimately, the degeneration reaches and breaks through the root-sheath of the hair, and the cavity thus left becomes the duct of the gland. Throughout life the cells lining the ultimate recesses of the gland undergo a similar fatty degeneration, and, breaking down, are discharged as the sebaceous secretion. The preputial and Meibomian glands are modified sebaceous glands.

FIG. 77.



(After Kölliker.) Illustrating Development of a Sebaceous Gland: *a*, hair; *b*, inner root-sheath; *c*, outer root-sheath of hair-follicle; *d*, rudiment of sebaceous gland, its central cells having already undergone fatty degeneration.

*The Mammary Glands*, so characteristic of Mammalia, are probably specially-developed but modified sebaceous glands: they arise in the embryo much as the sebaceous glands do, and their secreting cells during lactation undergo the same sort of fatty degeneration.

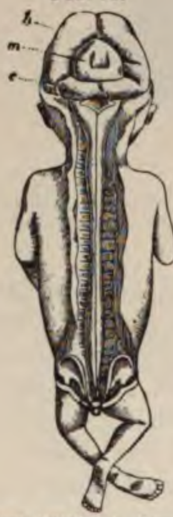
*The Development of the Nervous System.*—The origin of the rudiments of the cerebro-spinal axis from the thickened epiblast of the medullary groove has already been described, as also the subsequent infolding of the sides of the groove to enclose the medullary canal. From the lining cells of this canal and their direct descendants are developed all the essential parts (nerve-cells and nerve-fibres of the nervous system), and in addition the supporting tissue (neuroglia) of the main nerve-centres. The retina is an offshoot of the primitive neural canal; the peculiar "end-organs" of the sensory fibres in other organs of special sense, though derived from the epiblastic layer of the embryo, do not arise from the involuted epiblast of the neural canal, but from the general external epiblastic layer.

All true nerve-tissues of the body develop from the epiblast, not only in man, but in all multicellular animals: put in another form, we may say that the primitive external layer of the gastrula (p. 109), which places organisms which continue throughout life as mere gastrulæ (*e.g.* hydra) in immediate relations with their environment, is the layer which develops the essential parts of the sense-organs, of the nerve-fibres, and the nerve-cells of more complex animals.

*The Development of the Spinal Cord.*—When the neural canal is first closed in, the brain is nearly as long as the spinal cord: the latter, however, quickly increases in relative length, while the embryo is growing, as it does at first, mainly by additions to its posterior end.

At the time of the formation of the most posterior mesoblastic somite the spinal cord is well marked, and has already attained some of its permanent external characters. In the human embryo (as first pointed out by Ecker[1]) it extends beyond the last coccygeal vertebræ for a time (Fig. 78). The extension of the spinal cord along the whole spinal canal is permanent in many animals, but in the human fœtus the spinal column elongates more rapidly than the spinal cord, so that the latter ultimately extends only so far as the upper lumbar region, and the roots of the spinal nerves come to pass more and more obliquely backward as they are farther distant from the head, because their intervertebral foramina have relatively shifted backward in consequence of the elongation in that direction of the spinal column: in this way the *cauda equina* is produced by a sort of dragging backward of the lumbar and sacral spinal roots, in order that they may reach their foramina of exit. The cervical and lumbar enlargements of the spinal cord appear about the end of the third month.

FIG. 78.



(From Kölliker.) Human Embryo of three months, natural size (the brain and spinal cord exposed): *h*, cerebral hemisphere; *m*, mid-brain; *c*, cerebellum: behind the latter are seen the medulla oblongata and the spinal cord, the latter reaching to the tip of the coccyx.

When the neural canal in the spinal region is first completely closed in, it presents the form (Fig. 32) of an oval tube; its walls are fairly uniform in thickness throughout, and consist of several rows of cells.

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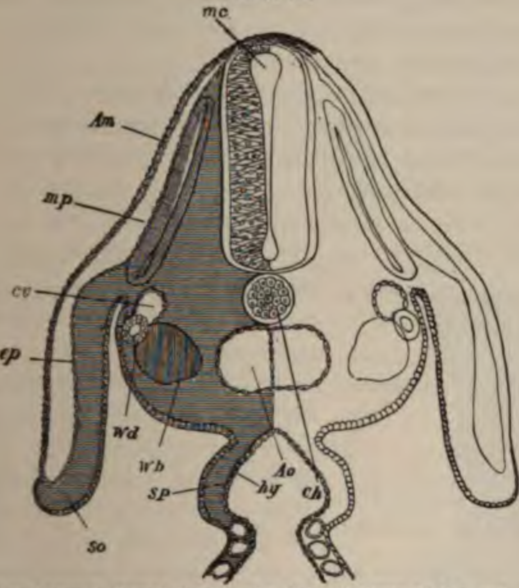
[1] *Icones physiologicæ*, 2d ed.

Soon after this the cord and its central canal become elongated dorso-ventrally. Fig. 79, taken from a chick embryo at the end of the third day of incubation, illustrates this stage.

In the adult spinal cord we find (*a*) the ciliated epithelium lining the central canal; (*b*) the gray matter, with its nerve-cells and medullated and non-medullated nerve-fibres; (*c*) the white matter, composed essentially of medullated fibres. The origin of these parts from the primitively uniform cells forming the spinal portion of the neural tube has not yet been satisfactorily made out. It is, however, probable that the ciliated lining cells correspond to the epitrichial layer of the epiblast (p. 146); that the nerve-cells and their processes (the axis-cylinders of nerve-fibres) are developed from an epiblastic layer equivalent morphologically to that which gives rise to the Malpighian layer of the epidermis; and that the peculiar supporting tissue of the spinal cord and brain (neuroglia) is the representative of the horny layer of the epidermis.

FIG. 79.

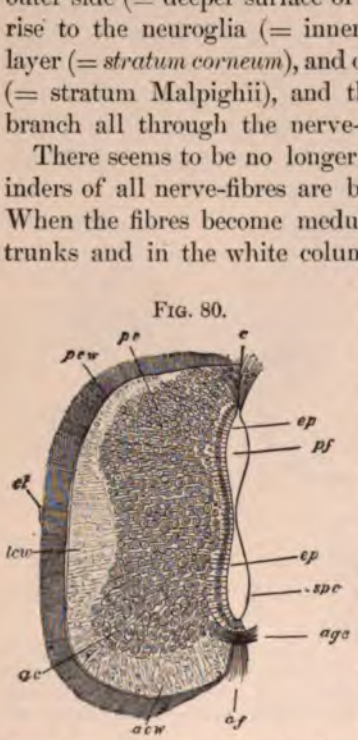


Transverse Section through Dorsal Region of a Chick Embryo at the end of the third day of incubation (from Balfour; semi-diagrammatic); *Am*, amnion; *mp*, muscle-plate; *cv*, cardinal vein; *Ao*, dorsal aorta: the section passes through the point of bifurcation of the aorta; *ch*, notochord; *Wd*, Wolffian duct; *Wb*, Wolffian body; *ep*, epiblast; *so*, somatopleure; *SP*, splanchnopleure; *hy*, hypoblast.

As usually described, after the differentiation of the lining cells of the *canalis centralis* the cells immediately outside it multiply rapidly and give rise to the nerve-cells and fibres of the gray matter. This cell-multiplication occurs mainly in the deepest stratum next the epithelium of the central canal, much as is the case in the growth of the epidermis from the deeper-placed cells of its Malpighian layer; but in the spinal cord the horny cells are from the first differentiated as the neuroglial network, and do not give rise to a special stratum as in the epidermis. Since the neural tube is but an involuted layer of the skin, and the cells lining its canal correspond to the primitive outer layer of the epidermis, it seems not improbable that it may ultimately be found that the cells of the developing gray matter multiply chiefly on its outer side (= deeper surface of epidermis), and that some of them give rise to the neuroglia (= inner) but morphologically more superficial layer (= *stratum corneum*), and others to the nerve-cells and their branches (= stratum Malpighii), and that the neuroglial cells then grow and branch all through the nerve-centre.

There seems to be no longer any reasonable doubt that the axis-cylinders of all nerve-fibres are branches (often very long) of nerve-cells. When the fibres become medullated, as in most cerebro-spinal nerve-trunks and in the white columns of the cord, the primitive cell-process becomes enveloped by a series of mesoblastic cells which give rise to the medullary and primitive sheaths, and whose boundaries are indicated by the nodes of Ranvier.

FIG. 80.



(From Balfour.) Section across Developing Spinal Cord of a Chick, on the seventh day of incubation: *pcw*, dorsal white column; *lcw*, lateral white column; *acw*, ventral white column; *c*, tissue filling up region where dorsal (posterior) fissure of the spinal cord will be formed; *pc*, posterior (dorsal) horn of gray matter; *ep*, cells lining cavity of neural canal; *agc*, anterior gray commissure; *pf*, dorsal part of spinal canal; *spc*, ventral part of spinal canal; *af*, anterior (ventral) fissure.

The white matter of the spinal cord first appears as a very thin layer, and, in the human embryo, at four places, as an anterior and a posterior white column on each side, on a level with the origin of the future anterior and posterior (= dorsal and ventral) nerve-roots.[1] It rapidly increases in thickness and covers the whole gray matter (Fig. 80). The anterior white commissure is formed very soon after the first appearance of the white matter.

The gray matter soon grows out on each side to form its anterior and posterior (ventral and dorsal) cornua. One conspicuous band of its fibres (*agc*, Fig. 80) passes across the middle line just below the neural canal, and forms the *anterior gray commissure*, through which fibres from both sides cross. There is also a well-marked dorsal extension of the gray matter along the sides of the neural canal. There is at this stage no trace of either the anterior or posterior fissure of the spinal cord.

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[1] See Balfour: *Comp. Embryology*, vol. ii. p. 343.

The anterior fissure is formed by a downgrowth, on each side of the middle line, of the anterior cornua and of the anterior white columns of the spinal cord; its commencement (*af*) is shown in Fig. 80.

The origin of the posterior (dorsal) fissure is not yet known with certainty. It is developed later than the anterior fissure, and Balfour[1] believes it to be due to an atrophy of the dorsal part of the primitive neural canal, though, as he says, "the exact mode of its formation seems to me to be still involved in some obscurity."

The spinal nerve-cells are arranged in groups answering in general to the mesoblastic somites and to the nerve-roots, so that the spinal cord, even in its adult structure, is a segmented organ. This morphological fact has no doubt important physiological consequences, but the field for research which it opens has as yet been little explored.

*The Spinal Nerves.*—Following Remak, most embryologists until twenty years ago believed that the peripheral nerves developed from the mesoblast, and only secondarily became connected with the central nervous system. His[2] was the first to prove by direct observation that the spinal nerves are outgrowths of the neural tube; and his observations have since been extended by many workers, so that it is now well established that all the nerves and ganglia of the body, so far as their essential nervous elements are concerned, are derived from the primitive medullary or neural tube.

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[1] According to Balfour's observations on the chick embryo, the posterior fissure is formed on the seventh day of incubation. The neural canal has by this time become divided (Fig. 80) into an upper (dorsal) and lower (ventral) dilatation, separated by a narrow channel. The dilatations are known, respectively, as the posterior and anterior canals.

"Between the posterior horns of the cord the epithelium forming the root of the posterior canal is along the middle line covered by neither gray nor white matter, and on the seventh day is partially absorbed, thus transforming the canal into a wedge-shaped fissure, whose mouth, however, is seen in section to be partially closed by a triangular clump of elongated cells (Fig. 80, *c*). Below this mass of cells the fissure is open. It is separated from the 'true spinal canal' by a very narrow space, along which the side-walls have coalesced. In the lumbar and sacral regions the two still communicate."

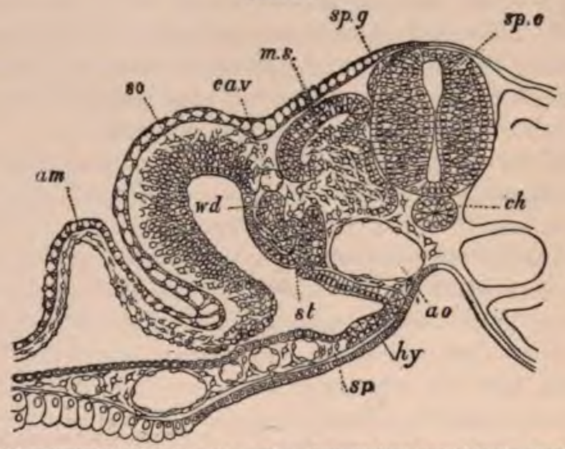
"We thus find, as was first pointed out by Lockhart Clarke, that the anterior and posterior fissures of the spinal cord are, morphologically speaking, entirely different. The anterior fissure is merely the space left between two lateral downward growths of the cord, while the posterior fissure is part of the original neural canal separated from the rest of the cavity (which goes to form the true spinal canal, *canalis centralis*) by a median coalescence of the side-walls."

"It seems to me probable, though further investigations on the point are still required, that the dorsal fissure is a direct result of the atrophy of the dorsal part of the central canal of the spinal cord."

[2] *Untersuch. üb. d. erste Anlage d. Weibelthierleibes*, 1868. See also Balfour: *Phil. Trans.*, 1876; and W. His, "Ueber d. Anfänge d. Periph. Nervensystems," *Arch. f. Anat. und Physiol.*, 1879.

The posterior roots of the spinal nerves are the first to appear in the embryo. They originate in all the higher Vertebrata from a lateral outgrowth of the epiblastic lining of the neural canal, which develops just before the closure of the tube (Fig. 81). This outgrowth (*spg*) forms a ridge on each side of the neural canal extending from the region of the corpora quadrigemina to the hinder end of the spinal cord: it is named the *neural crest*. The neural crest at intervals gives origin to pear-shaped outgrowths, the commencements of the dorsal spinal roots; between these it soon disappears. Each outgrowth differentiates into a narrow proximal stalk (the *root*), a thicker part (the *ganglion*) succeeding this, and a stem (nerve) on the distal side of the ganglion (Fig. 82). The dorsal attachment of the root soon begins to shift its position: it slides from the middle line to its permanent origin at the outer side of the posterior column, and the neural crest disappears. In the rabbit the development of the posterior spinal roots commences on the ninth day.

FIG. 81.



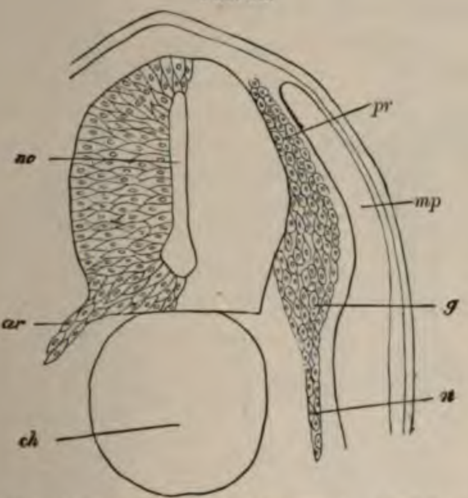
Cross-section of Embryonic Duck at a stage when twenty-four mesoblastic somites had developed (from Balfour and Foster): *am*, amnion; *so*, somatopleure; *sp*, splanchnopleure; *Wd*, Wolffian duct; *st*, segmental tube; *ca.v*, cardinal vein; *ms*, muscle-plate; *sp.g*, spinal ganglion; *spc*, spinal cord; *ch*, notochord; *ao*, aorta; *hy*, hypoblast.

The anterior roots arise later than the posterior as outgrowths from the wall of the neural canal (*ar*, Fig. 82). They join the posterior root beyond its ganglion. Both roots are at first cellular, and nerve-fibres (or their axis-cylinders) appear earlier in the anterior. These axis-cylinders are outgrowths from nerve-cells in the gray matter of the cord. It is possible that the keratin structures of the white fibres correspond to the horny layer of the epidermis, and are formed from the cells of the primitive roots.

The anterior roots do not originate in the same vertical plane as the posterior roots, but alternate with them: a condition which persists in the adult. Many cranial nerves (I., III., V., VII., VIII., IX., X.) arise from a neural crest similar to, and continuous with, that of the spinal cord: whether such nerves are strictly comparable, morphologically, to posterior spinal roots is as yet doubtful, and there is no doubt that some of them do not physiologically correspond to the posterior spinal roots.

*The Sympathetic Nervous System* was first shown by Balfour[1] to arise in certain fishes as an offshoot of the cerebro-spinal centre and its nerves. A similar origin in birds and mammals has since been discovered[2] by Schenk and Birdsell. The sympathetic ganglia appear as "swellings on the main branches of the spinal nerves some way below the ganglia."

FIG. 82.



Cross-section through Dorsal Region of a Torpedo Embryo: *pr*, posterior root of spinal nerve; *g*, spinal ganglion; *n*, prolongation of dorsal nerve-root beyond its ganglion; *ar*, anterior root of spinal nerve; *ch*, notochord; *nc*, neural canal; *mp*, muscle-plate.

Subsequently, these ganglia separate from the spinal nerve, remaining connected with it by a short branch (*ramus communicans*). The sympathetic ganglia of elasmobranchs on their first appearance are quite separate, the longitudinal commissure being a later development; but in mammals they are (at least in certain regions, as the neck) connected from the first by a commissural cord.

*The Development of the Brain* is so extensive a subject that only some of its main features can be here described.

When the medullary canal is formed it presents from the first an anterior (cephalic) wider portion, which is as long as, or longer than, the posterior narrower part, which ultimately develops into the spina cord.

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[1] *Monograph on Elasmobranch Fishes.*

[2] "Ueber d. Lehre von der Entwickelung d. Ganglien d. Sympatheticus," *Mith. a. d. Embryol. Instit.*, Wien, 1879.

The cephalic portion of the neural tube next dilates so as to forn (Fig. 68) an anterior, *h′*, and posterior, *h‴*, vesicle or dilatation. A third vesicle soon appears between the first pair at the point marke *h″* in the figure. These three primary vesicles are known as the *fore-* the *mid-*, and the *hind-brain*. Their subsequent development is essentially the same in the bird and the mammal, so that Fig. 83, which represents a chick embryo viewed from above during the second day of incubation, may be used to illustrate the condition of the cerebral vesicles of

FIG. 83.

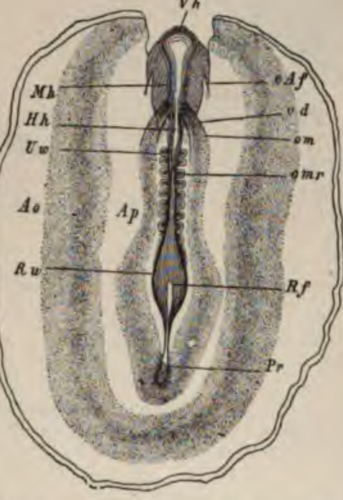


FIG. 84.

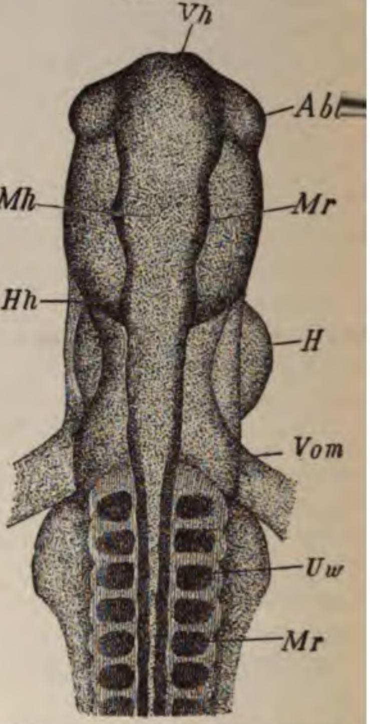


FIG. 83.—(From Kölliker.) Chick Embryo ⅙ inch (4.2 mm.) in length, viewed from above, toward the end of the second day of incubation (magnified about 19 diameters): *Ao*, vascular area; *Ap*, pellucid area; *Vh*, fore-brain; *Mh*, mid-brain; *Hh*, hind-brain.

FIG. 84.—Anterior Part of the Embryo represented in Fig. 83, more magnified: *Vh*, fore-brain; *Abl*, optic vesicles; *Mh*, mid-brain; *Mr*, its wall; *Hh*, hind-brain; *H*, heart; *Vom*, vitelline vein; *Uw*, mesoblastic somite.

the human embryo at a corresponding stage. Fig. 84 represents the anterior part of the same embryo, more magnified (40 diameters).

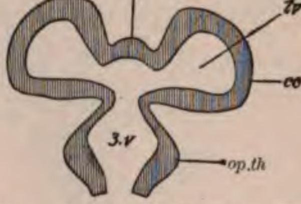
The cavity of the vesicle of the fore-brain remains in the adult mammal as the third ventricle of the brain: its front wall becomes the *lamina terminalis*.

Very early in development the fore-brain vesicle buds out on each side to form the *optic vesicles* (*Abl*, Fig. 84). These ultimately form the retinas, and their later development will be described subsequently

(p. 163). They quickly shift back, so as to become attached to the mid-brain.

Next, a median forward outgrowth from the fore-brain is developed: it divides into right and left halves, which become the cerebral hemispheres (Fig. 85). Each division contains within it an extension of the cavity of the fore-brain vesicle; these cavities remain throughout life as the lateral ventricles, and their communications with the primitive cavity of the fore-brain (third ventricle) are the foramina of Monro. The outgrowths from the fore-brain to form the cerebral hemispheres are known as the *cerebral vesicles*. From their under surfaces, near their anterior ends, olfactory lobes bud out as hollow sacs, which subsequently become solid in Mammalia. While the cerebral vesicles are forming, the hind-brain partially subdivides into a dorsal expansion (epencephalon), the rudiment of the cerebellum, and a ventral portion (metencephalon), the rudimentary medulla oblongata. The brain may at this stage be represented by the diagram, Fig. 86. Omitting the optic and olfactory vesicles, it may be described as consisting of five main divisions. The foremost of these are the paired cerebral vesicles; next comes the vesicle of the original fore-brain (I, Fig. 86); then, in order, the vesicle of the mid-brain, and the vesicle of the hind-brain with its subdivisions into cerebellar and medullary portions. The five main regions of the brain are thus mapped out early in embryonic development.

FIG. 85.



(From Foster and Balfour.) Diagrammatic Horizontal Longitudinal Section through the Fore-brain: *3.v*, third ventricle or original cavity of fore-brain; *lv*, lateral ventricle; *lt*, lamina terminalis; *ce*, rudiment of cerebral hemisphere; *op.th*, rudiment of optic thalamus.

The cells lining the vesicles give rise to the ependyma of the ventricles, to the white and gray matter of the brain, and to its neuroglia. The investing mesoblast gives origin to the blood-vessels, the pia mater, the choroid plexuses, and so forth. In some parts the epiblastic walls of the primary cavities thicken greatly; in others they remain thin, even forming throughout life a mere single layer of cells, as on the roof of the fourth ventricle of the adult brain.

The cerebral vesicles (prosencephalon) give rise by the thickening of their roofs and outer sides to the cerebral hemispheres. Their inner sides for a considerable area remain very thin, and, coming nearly in contact in the middle line, leave a space between them which is later closed in above by the corpus callosum and below by the fornix; the space thus enclosed is the *fifth ventricle* of the mammalian brain, which differs from all the others in not being a remnant of the original cavity of the medullary canal.

The multiplication and modification of the epiblast cells forming the floor of the primary cerebral vesicle give rise to the *corpus striatum*.

FIG. 86.

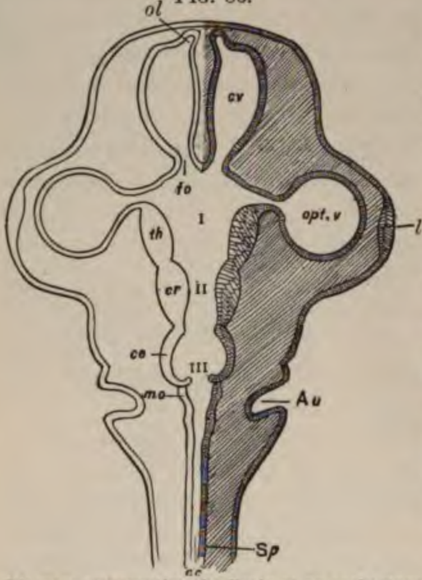


Diagram representing the Brain at an early stage of development: I, cavity of primary fore-brain: the thickened epiblast, *th*, on its sides will become the optic thalami; *cv*, cerebral vesicle: its lining epiblast will form the cerebral hemisphere, and its cavity remain as a lateral ventricle; *ol*, olfactory lobe; *fo*, foramen of Monro; *opt.v*, optic vesicle, still connected with the fore-brain: its lining epiblast will become the retina; *l*, thickened external epiblast, the rudiment of the lens. II, cavity of primary mid-brain (mesencephalon) becoming narrowed to form the aqueduct of Sylvius; its walls, *cr*, thicken above, below, and laterally to form the corpora quadrigemina and crura cerebri. III, cavity of primary hind-brain, subdividing to form the cerebellum (epencephalon) and medulla oblongata (metencephalon): its remnants in the adult brain form the fourth ventricle; *ce*, rudiment of cerebellum; *mo*, rudiment of medulla oblongata; *Sp*, spinal cord; *cc*, canalis centralis; *Au*, auditory pit.

The primitive fore-brain, after it has budded off the optic and cerebral vesicles, is named the diencephalon or inter-brain. It develops on its dorsal surface the pineal process and gland;[1] its sides form the optic thalami and part of the cerebral peduncles; its floor gives origin to the infundibulum,[2] part of the crura cerebri, tuber cinereum, and optic chiasma; its cavity remains as the third ventricle.

*The anterior commissure* in amphibia and reptiles is a complex structure, consisting of an upper portion developed from the cerebral vesicles, and representing a rudimentary corpus callosum, and a lower portion, the true anterior commissure, developed from the diencephalon, and separate in mammals from the corpus callosum (Osborn). The middle commissure is also developed from the diencephalon.

The primary mid-brain (mesencephalon) gives origin to the following parts: its roof and sides thicken to form the corpora quadrigemina; its floor and sides form the posterior parts of the crura cerebri; its cavity becomes the aqueduct of Sylvius; the posterior commissure is formed by growth of a portion of its fibres across the middle line.

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[1] The so-called pineal gland, which has long been a puzzle, has lately been proved to be the remnant of a median eye which once existed on the top of the head. This eye is still present in an imperfect form in some fishes (Anguis) and reptiles (Hatteria and other lizards). The pineal body appears between the sixth and seventh weeks in the human embryo. Embryological investigation has shown that the pineal body in many existing higher vertebrates still originates as an offshoot of the optic vesicles (*vide* Haddon: *Introd. to Study of Embryology*, fig. 138, p. 163).

[2] The infundibulum subsequently becomes closely connected with the pituitary body,

The embryonic hind-brain, after separating into epencephalon and metencephalon, forms the following regions of the adult brain: the epencephalon develops into the cerebellum, the valvula cerebelli or "valve of Vieussens," the pons Varolii, and anterior peduncles of the cerebellum; its cavity remains as the anterior part of the fourth ventricle. The metencephalon (after-brain), which narrows behind and is continuous with the spinal cord, develops dorsally the ependyma lining, on its under side, the choroid plexus of the fourth ventricle; fusing with this, it forms the *tela vasculosa;* the sides and the floor of the metencephalon form the medulla oblongata or myelencephalon and the posterior peduncles of the cerebellum; its cavity remains as the posterior portion of the fourth ventricle of the brain and communicates behind with the central canal of the spinal cord.

In some of the lower vertebrates the three primary vesicles and their outgrowths remain in the same horizontal plane, so that a section including them all, such as is given in the diagram, Fig. 86, would be possible. This is not the case in higher Vertebrata: in reptiles, birds, and mammals the embryonic brain very early becomes bent in the dorso-ventral plane, so that the brain in vertical longitudinal section is S-shaped (2, Fig. 87). The first and most important bend occurs in the region of the mid-brain (*mb*, Fig. 88), just in front of the anterior end of the notochord: it is known as the *cranial flexure.*

Soon after the vesicle of the cerebral hemispheres becomes bilobed the mesoblast extends between the hemispheres; it gives origin to the *falx cerebri* and other non-nervous parts. The lateral ventricles are at first very large (Fig. 88), as are also the foramina of Monro. As development proceeds, the walls of the vesicles, at first nearly uniformly thin, thicken below and form the corpora striata, which project into the lateral ventricles, causing the cavities of these to assume a somewhat

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which is usually described as a part of the brain: it is really an outgrowth from the primitive buccal cavity (stomadæum), and possibly is the remnant of an ancestral sense-organ.

"In Mammalia . . . . the part of the infundibulum which lies at the hinder end of the pituitary body is at first a simple finger-like process of the brain; but its end becomes swollen and the lumen in this part becomes obliterated. Its cells, originally similar to those of the other parts of the nervous system, and even [giving rise to] differentiated nerve-fibres, partly atrophy and partly assume an indifferent form, while at the same time there grow in between them numerous vascular and connective-tissue elements. The [part] of the infundibulum thus modified becomes inseparably connected with the true pituitary body, of which it is usually described as the posterior lobe."

"In the latter stages of development the unchanged [nervous] portion of the infundibulum becomes gradually prolonged and forms an elongated diverticulum of the [floor of the] third ventricle, the apex of which is in contact with the pituitary body."

"The posterior part of the primitive infundibulum becomes the corpus albicans, which is double in man and the higher apes; the ventral part of the posterior wall forms the tuber cinereum" (Foster and Balfour: *Embryol.*, p. 372).

semilunar shape.[1] The horns of these demilunes become the ascending and descending cornua of the lateral ventricles of the adult brain.

The corpora striata are from the first continuous posteriorly with the optic thalami. As they develop, the surfaces of contact become so extensive that the original sharp demarcation between the cerebral vesicles and the thalamencephalon is obscured.

The outer walls of the cerebral vesicles (or, as we may now name them, the cerebral hemispheres) thicken; their inner walls remain thinner, but give rise to two folds which project into the lateral ventricle. These folds extend from the foramen of Monro along nearly the whole length of the descending cornu. The upper (dorsal) one forms the hippocampus major.

FIG. 87.

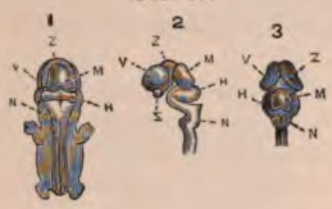

FIG. 88.

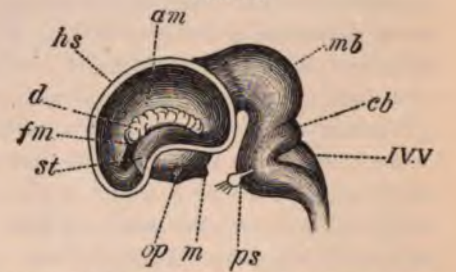

FIG. 87.—(From Kölliker.) Central Nervous System of a Seven Weeks' Human Embryo: 1, from dorsal side, with brain and spinal cord exposed; 2, lateral view of brain and upper part of spinal cord; 3, dorsal view of brain: V, cerebral vesicle; Z, diencephalon; M, mid-brain; H, epencephalon; N, metencephalon; X', ventral anterior end of diencephalon where tuber cinereum will develop.

FIG. 88.—(After Mihalkovics.) Lateral View of Brain of Calf Embryo, 5 cm. long. The outer wall of the hemisphere is removed, so as to give a view of the interior of the left lateral ventricle: *hs*, cut wall of the hemisphere; *st*, corpus striatum; *am*, hippocampus major; *d*, choroid plexus of lateral ventricle; *fm*, foramen of Monro; *op*, optic tract; *m*, infundibulum; *mb*, mid-brain; *cb*, cerebellum; *IV.V*, roof of fourth ventricle; *ps*, pons Varolii, close to which is the fifth nerve with the Gasserian ganglion.

"The wall of the lower fold becomes very thin, and a vascular plexus derived from the connective tissue [mesoblastic] septum between the hemispheres is formed outside it." The fold next projects into the cavity of the lateral ventricle, and with its mesoblastic lining forms the choroid plexus.

The inner, or median, thin walls of the cerebral hemispheres come in contact, and to a great extent fuse across the middle line and form the *septum lucidum*. In man a cavity (part of the original space between the cerebral vesicles) persists in this septum, and is known as the fifth ventricle of the brain. In the lower part of the septum lucidum transverse fibres form the true anterior commissure. In its upper part are next developed the vertical fibres of the *fornix;* these diverge behind as the *posterior pillars*, and enter the cornu ammonis. "Ventrally, they are continued, as the descending or anterior pillars of the fornix, into the corpus albicans, and thence into the optic thalamus."

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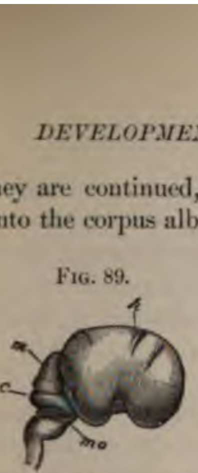
[1] Balfour: *Comp. Embryol.*, vol. ii. p. 362.

The corpus callosum develops later: it begins in the upper part of the septum lucidum, and at first only its front portion (genu, rostrum) is formed. This portion only is found in the lower mammals; in the higher, the posterior portion is gradually developed as the cerebral hemispheres grow backward.

FIG. 89.



(From Kölliker.) Brain of Three Months' Human Embryo, natural size: *h*, right cerebral hemisphere: all its lobes and the fissure of Sylvius are distinguishable; *m*, mid-brain; *c*, cerebellum; *mo*, remnant of membrana obturatorii ventriculi, IV, prolonged from cerebellum over medulla.

The cerebral hemispheres of the human embryo are at first smooth on the surface, and do not cover (V, Fig. 87) the thalamencephalon. Extending backward, they overlap the optic thalami (Figs. 89 *et seq.*) during the second and third months of intra-uterine life. During the fifth month the backward extension of the hemispheres covers most of the mid-brain, and during the sixth month the latter is completely overlapped by them. Later still, the cerebellum is similarly completely concealed from above.

FIG. 90.

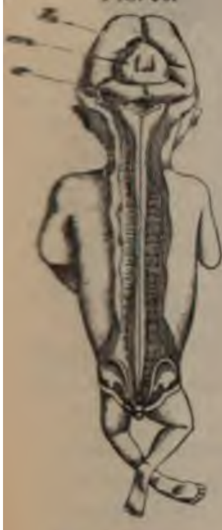


FIG. 91.

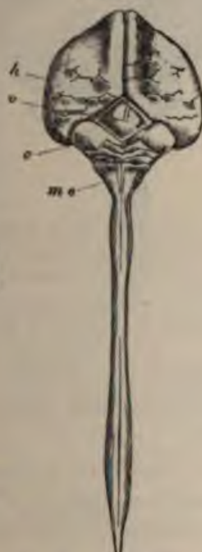


FIG. 92.

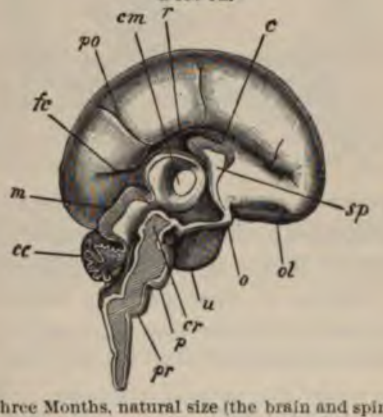


FIG. 90.—(From Kölliker.) Human Embryo of Three Months, natural size (the brain and spinal cord exposed): *h*, cerebral hemisphere; *m*, mid-brain; *c*, cerebellum: behind the latter are seen the medulla oblongata and the spinal cord, the latter reaching to the tip of the coccyx.

FIG. 91.—(From Kölliker.) Brain and Spinal Cord of Four Months' Human Embryo, natural size: *h*, cerebral hemispheres; *v*, corpora quadrigemina (mid-brain), partly overlapped by cerebral hemispheres; *c*, cerebellum: its apparently hindmost fold is only the membrana obturatoria; *mo*, medulla oblongata.

FIG. 92.—Brain of Human Embryo of the Fifth Month, natural size (from Kölliker): *pr*, pyramids; *p*, pons; *cr*, crus cerebri; *u*, temporal lobe; *o*, optic chiasm; *ol*, olfactory lobe; *sp*, septum lucidum; *c*, corpus callosum; *cm*, soft commissure; *po*, parieto-occipital fissure; *fc*, calcarine fissure; *m*, mid-brain; *cc*, cerebellum.

The fissures of the cerebral hemispheres have from their mode of origin been divided by Kölliker into primary and secondary: the primary fissures are due to infoldings of the whole thickness of the thin walls of the cerebral vesicles at an early stage of development; the secondary are due to later superficial outgrowths (convolutions of the surface of the hemisphere). His distinguishes them as "total" and "cortical" fissures respectively. The primary fissures (Figs. 91 and 93) appear during the third month, are most marked in the fourth, and for the most part disappear during the fifth, so that during the sixth month the outer cerebral surface is again almost quite smooth (Fig. 94). They appear to be due to a more rapid growth for a time of the cerebral hemispheres than of the cranial cavity, so that the former have to become folded in order to gain room.

Fig. 93.

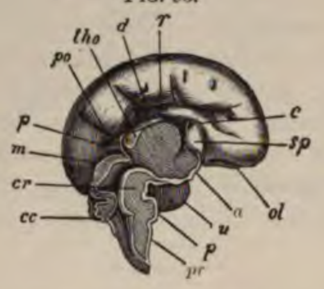


Fig. 94.

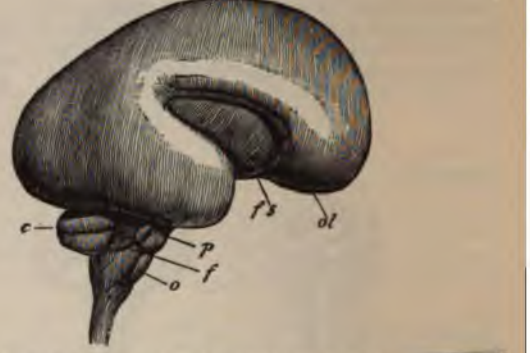


Fig. 93.—Brain of Four Months' Human Embryo, natural size (from Kölliker): *pr*, pyramids; *p*, pons; *cr*, crus cerebri; *o*, floor of third ventricle in region of optic chiasma; *a*, temporal lobe; *ol*, olfactory lobe; *sp*, septum lucidum; *c*, corpus callosum; *po*, occipito-parietal sulcus; *r*, pineal gland; *m*, mid-brain; *cc*, cerebellum.

Fig. 94.—Brain of Six Months' Human Embryo, natural size (from Kölliker): *ol*, olfactory lobe; *fs*, fissure of Sylvius; *c*, cerebellum; *p*, pons Varolii; *f*, flocculus; *o*, olivary body.

Certain of these primary fissures are, however, permanent—namely, the *sulcus hippocampus*; the *sulcus parieto-occipitalis* (Fig. 93, *po*); the *sulcus calcarinus* (Fig. 92, *fc*); the infolding (p. 160) of the ependyma to cover the choroid plexuses. The *Sylvian fissure* may perhaps be classed with the permanent primary fissures, though it differs from the others in some important respects.[1] It is conspicuous in three-month human embryos (Fig. 89) as a small depression on the under side of the expanding cerebral vesicles. It corresponds in position to the internal region in which the corpus striatum will form; and it seems as if in this region the wall of the cerebral vesicle chiefly thickens on its inner and elsewhere on its outer side. Hence the fissure is not due to a true infolding of the wall of the vesicle, but is a mere valley left on the exterior by excessive superficial thickening of the parts surrounding it.

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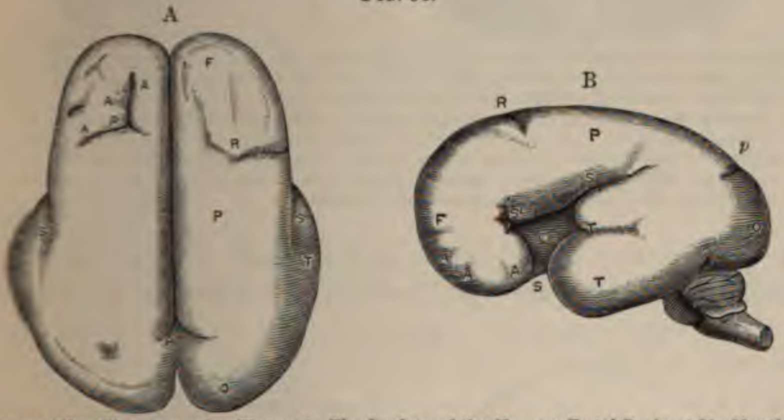
[1] Kölliker: *Entwicklungsgeschicte*, vol. ii. p. 558.

Its external form at this time corresponds to that of the corpus striatum (Fig. 94). The convolutions of the island of Reil only become distinct toward the end of fœtal life.

The Sylvian fissure marks off with tolerable distinctness the frontal from the temporal lobes; these, with the olfactory lobes, are the only well-marked primary subdivisions of the human cerebral hemispheres. The parieto-occipital fissure, which appears almost contemporaneously with the Sylvian, imperfectly marks off the occipital lobe (Fig. 92).

The secondary fissures appear toward the end of the fifth and during the sixth month. They have been especially studied by Ecker,[1] to whose description the reader is referred. The secondary sulci appear about the beginning of the sixth month or the end of the fifth. The first is the central sulcus or fissure of Rolando (Fig. 95), which, so far as it extends, marks the dividing-line between the frontal and parietal lobes.

FIG. 95.



(From Allen Thomson, after Wagner.) The Surface of the Human Fœtal Brain at Six Months: A, from above; B, from the left side: F, frontal lobe; P, parietal lobe; O, occipital lobe; T, temporal lobe; A, A, A, first indications of the chief frontal convolutions; S, fissure of Sylvius; S', its anterior division; C, central lobe or island of Reil; R, fissure of Rolando; *p*, parieto-occipital fissure.

*The Development of the Eye.*—The eyes of Vertebrata originate as outgrowths (Fig. 84) from the fore-brain. These outgrowths appear in mammals even before the vesicles of the fore-brain are closed (Fig. 96). They are represented somewhat later in the diagram (Fig. 86), at a stage when the connection of their cavities with the fore-brain cavity has become narrowed. The narrowed stem is the *optic stalk;* the vesicle on its end is the *primary optic vesicle.* As the embryo develops the epiblast lining the primary optic vesicle comes nearly into contact with the external epiblast; but in mammals a layer of mesoblast always separates them (Fig. 86). The external epiblast (*l*, Fig. 86) covering the most projecting part of the primary optic vesicle thickens, and then

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[1] *Icones physiologicæ*, Leipzig, 1851–59; and *Arch. für Anthrop.*, 1868. The following may also be consulted: Kölliker, *Entwicklungsgeschicte*, Leipzig, 1879, p. 563 *et seq.;* Pansch. *Archiv f. Anthrop.*, 1868; Mihalkovics, *Entwick. d. Gehirns.*, 1877.

FIG. 96.

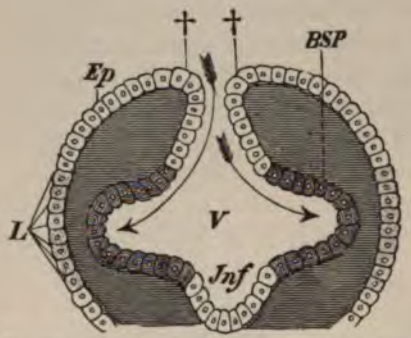


FIG. 97.

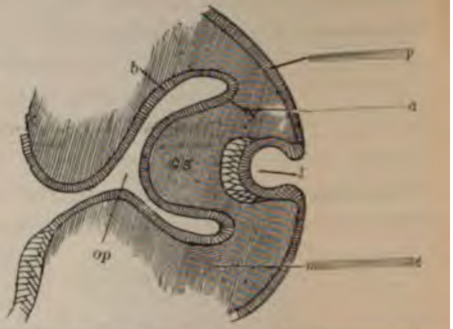
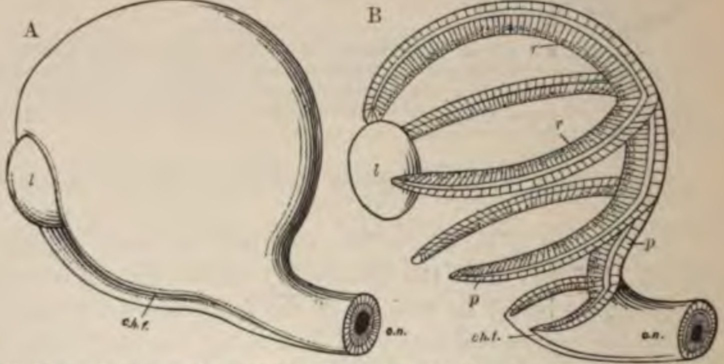


FIG. 96.—(After Wiedersheim.) *Ep*, epiblast, invaginated at † to line medullary groove; V, cavity of fore-brain (third ventricle); BSP, cells of optic vesicle; *Inf*, commencement of infundibulum; L, epiblast cells from which the lens is developed later.

FIG. 97.—Diagram: *op*, cavity of primary optic vesicle, nearly obliterated by the infolding of its epiblast to form the optic cup; *os*, cavity of optic cup; *b*, epiblast of posterior half of primary optic vesicle which will form the pigmentary layer of the retina; *a*, involuted epiblast of anterior half of primary optic vesicle: it gives origin to most of the retina; *l*, commencement of the lens; *me*, mesoblast; *ep*, external epiblast.

the primary optic vesicle doubles back on itself (Fig. 97), so as to nearly obliterate its original cavity, *op*, and form a new one, the second-ary optic vesicle, *os*, known as the *optic cup*. This cup has an outer, *a*, and an inner, *b*, wall of epiblast cells. These layers subsequently come into contact and completely obliterate the cavity of the primary optic

FIG. 98.

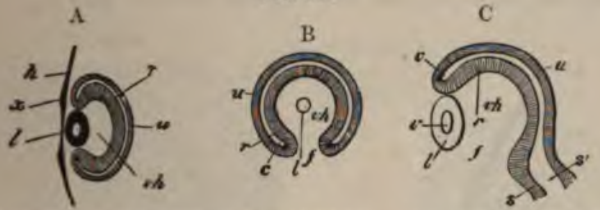


(From Haddon.) Diagrams illustrating the Formation of the Optic Cup and Choroidal Fissure. A, lateral view of the optic vesicle; B, skeletal view, the greater portion of the optic cup being supposed to be cut away; *ch.f*, chorodial fissure; *l*, lens; *o.n*, optic nerve; *p*, pigmentary layer of retina; *r*, cells which will form the retina inside the pigmentary layer.

vesicle. The outer gives rise to the pigmentary layer of the retina, the inner to the remainder of that organ.

When the primary optic vesicle pits-in to form the optic cup, its nvolution occurs not only from without in, but also from below up Fig. 98). Sections of the secondary optic vesicle at this stage therefore iffer much in appearance when cut in different planes: this is illustrated in Fig. 99. A horizontal section through the the embryonic eye is represented at *A*, a vertical transverse section at *B*, and a vertical longitudinal section at *C*.

FIG. 99.



Horizontal Section through Secondary Optic Vesicle; B, cross-section through the same; C, vertical section passing through the choroidal fissure: *vh*, cavity of secondary optic vesicle: the mesoblast extends into it and forms later the vitreous humor; *f*, choroidal fissure; *h*, superficial epiblast; *x*, its thickening over the surface of the optic vesicle; *l*, portion of thickened external epiblast which has been separated to form the lens, which latter is still a hollow vesicle; *s*, inner, *s'*, outer layer of optic cup.

The cavity of the secondary optic vesicle is, as shown in Fig. 97, filled from the first with mesoblast. The infolding of the primary vesicle extends to the optic stalk, which consequently forms a double-layered epiblastic tube open on its under side (Fig. 100, A). Mesoblast extends into its cavity and forms the central artery of the retina and other vessels, and their enveloping connective tissue. The sides of the

FIG. 100.

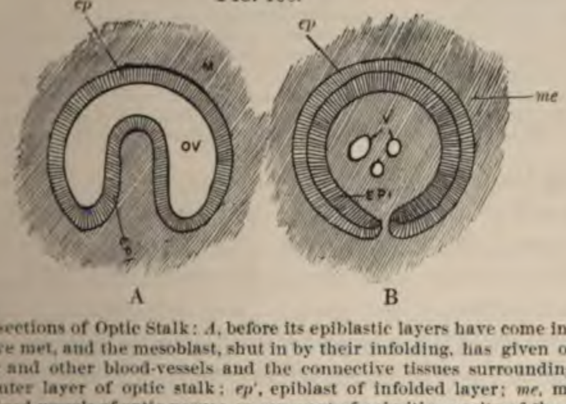


Diagram. Cross-sections of Optic Stalk: *A*, before its epiblastic layers have come in contact; *B*, after they have met, and the mesoblast, shut in by their infolding, has given origin to the central artery and other blood-vessels and the connective tissues surrounding them: *ep*, epiblast of outer layer of optic stalk; *ep'*, epiblast of infolded layer; *me*, mesoblast; *v*, developing blood-vessels of optic nerve; *ov*, remnant of primitive cavity of the optic stalk.

stalk soon unite below (Fig. 100, B). As development proceeds, the optic stalk shifts back, so as to become attached to the optic chiasma. Its primitive cells form the neuroglia of the permanent optic nerves, the true optic nerve-fibres being a secondary development. Whether they arise from cells of the optic vesicle or as branches of cells in the mid-brain is not yet certain.

The first indication of the lens is a thickening of the epiblast covering the most projecting portion of the primary optic vesicle (Fig. 86, *l*). This thickening soon becomes hollow, and forms a pit (Fig. 101) communicating by a narrow aperture with the exterior. The mouth of the pit closes, and the epiblastic cavity thus formed (*l*, Fig. 99, A) separates from the rest of the outer epiblast (Fig. 102). The cells on the deeper side of the lens-cavity multiply rapidly, and form a thick layer, convex toward the surface of the head. They thus gradually obliterate the primitive cavity of the lens, and ultimately come into contact (Fig. 103) with the cells of the more superficial side. The deeper cells have by this time grown into nucleated fibres; the superficial cells form the epithelium covering the front of the embryonic lens. The lens capsule is probably a mere excretionary layer deposited by the cells which form the organ.

FIG. 101.

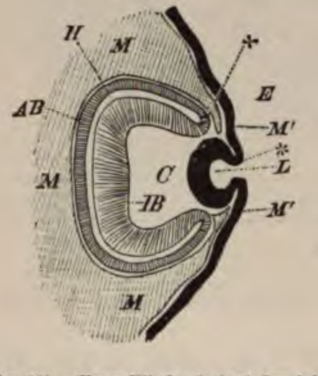


FIG. 102.

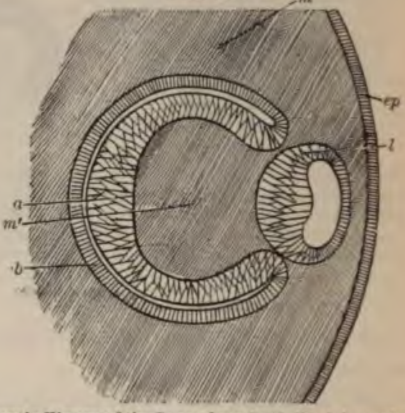


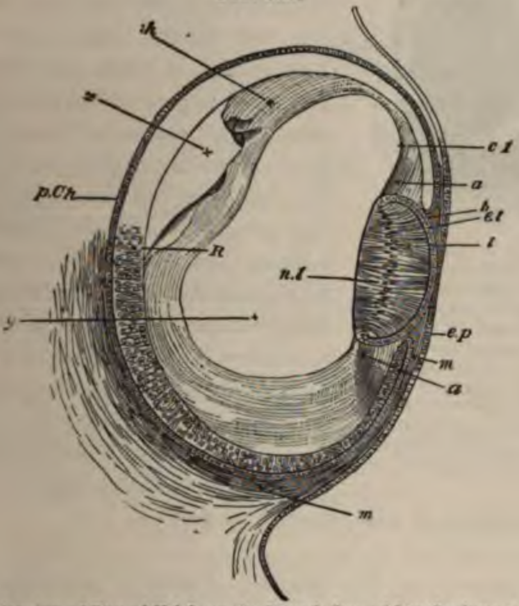
FIG. 101.—(From Wiedersheim.) Semi-diagrammatic Figure of the Secondary Optic Vesicle and of the Developing Lens: *IB*, layer of secondary optic vesicle which gives origin to most of the retina; *AB*, layer of secondary optic vesicle which gives origin to the pigmentary retinal layer; † indicates the place at which the primary optic vesicle has been doubled back on itself, *H*, remnant of cavity of primary optic vesicle; *L*, lens, as a cup open on the exterior; *, point of invagination of outer epiblast to form lens; *M*, mesoblast; *M'*, point from which mesoblast grows in to form iris and body of cornea; *C*, posterior chamber of eye, which becomes filled with mesoblast that ultimately forms the vitreous humor.

FIG. 102.—The Developing Eye in Horizontal Section at a stage soon after the lens has separated from the external epiblast (diagrammatic): *m*, mesoblast; *mi*, mesoblast included in secondary optic vesicle, the rudiment of the vitreous humor; *b*, outer layer of optic cup, which develops into the pigmentary retinal layer; *a*, inner layer of optic cup, which forms most of the retina between *b* and *a* is seen the remnant of the cavity of the primary optic vesicle; *ep*, external epiblast; *l*, rudiment of lens, separated from external epiblast, but still hollow, though its posterior wall has commenced to thicken and encroach on its cavity.

While the developmental changes described above are taking place the mesoblast surrounding the optic cup gives origin to the choroid and sclerotic, the ciliary muscle and ligamentum pectinatum, to most of the iris and of the ciliary processes. The anterior margin of the optic cup forms the *pars ciliaris* of the retina.

*The Choroidal Fissure* (Fig. 98) is the opening through which the mesoblast enters, from below, the cavity of the secondary optic vesicle; it sometimes remains unclosed during life, giving rise to the condition known as *coloboma*.

FIG. 103.

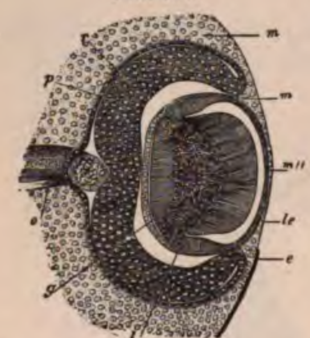


(From Balfour.) Section of Eye of Chick on the Fourth Day of Incubation: *e.p*, superficial epiblast of the side of the head; *R*, inner layer of optic cup; *p.Ch*, outer (pigmentary) layer of optic cup; *l*, lens, its cavity now quite obliterated, and its anterior cells remaining as a mere epithelial stratum, *el*; *m*, mesoblast surrounding optic cup, and about to form the choroid and sclerotic; *y*, commencement of vitreous humor.

The *vitreous humor* is formed by mesoblast which enters the secondary optic vesicle through the choroidal fissure.

The *cornea* is developed partly (conjunctival epithelium) from the epiblast left on the surface (*ep*, Fig. 102) when the lens is separated, and partly (body of cornea) from the mesoblast which grows in between this epiblast and the lens. This mesoblast (Fig. 104) is at first adherent to the outer surface of the lens and the inner surface of the corneal conjunctiva. It soon becomes cleft into an inner (iris) and outer (body of cornea) stratum. The cavity between these layers becomes the chamber of the aqueous humor, but is not dilated by liquid until near the normal time of birth. The epithelium on the back of the iris is an outgrowth from the epiblast of the lens: the membrane of Descemet is formed by flattening of mesoblast cells on the inner side of the cornea. The iris at first completely covers the front of the lens, this portion of it being known as the *pupillary membrane*. In the human race this membrane is normally absorbed before birth.

FIG. 104.



**Horizontal Section through the Eye of a Rabbit Embryo of Fourteen Days (from Kölliker; magnified about 62 diameters): *o*, optic nerve; *p*, pigmentary layer of retina; *r*, inner layer of retina; *m*, mesoblast surrounding secondary optic vesicle; *m''*, mesoblast in front of lens; *l*, lens: *le*, its anterior wall, formed of flattened cells; *e*, external epiblast, which is only represented in the lower part of the figure.**

*The Development of the Ear.*—The first indications of the ears are two pits (*Au*, Fig. 86) on the sides of the hind-brain. The mouths of these pits close very soon, and thus a pair of cavities lined by epiblast cells come to be buried in the mesoblast of the developing skull. The lining cells of these cavities become the epithelial structures and their derivatives (*e. g.* rods of Corti) of the labyrinth: the mesoblast immediately surrounding them gives origin to the remainder of the membranous internal ear; a cleft in it becomes the perilymph cavity, and on the outside of this it ossifies to form the bony internal ear. The tympanic cavity and membrane and the Eustachian tube are later developments from the first visceral cleft (p. 184).

*The Development of the Vascular System.*—"It seems probable—mainly, it must be admitted, on *a priori* grounds—that the [blood-] vascular and lymphatic systems have originated from the conversion of indefinite spaces, primitively situated in the general connective tissue, into definite channels. It is quite certain that vascular systems have arisen independently in many types." . . . . "On the whole, it would seem probable that the vascular system has in most cases arisen independently of the body-cavity [cœlome]. . . . . As pointed out by the Hertwigs, a vascular system is always absent where there is not a considerable development of connective tissue."[1]

The smaller blood-vessels often arise by a hollowing of the bodies and communicating branches of mesoblast cells. The superficial protoplasm and some of the multiplying nuclei of these cells form the walls of the primitive blood-vessels; and in mammals the first blood-corpuscles are formed by a budding-off of nuclei, surrounded by some cell-protoplasm from the interior of the primary blood-channels. The blood and blood-vessels of the higher vertebrates are first developed in that portion of the somatopleure which forms the proximal part of the yelk-sac (Fig. 55, *av*) and is known as the *vascular area* (p. 128).

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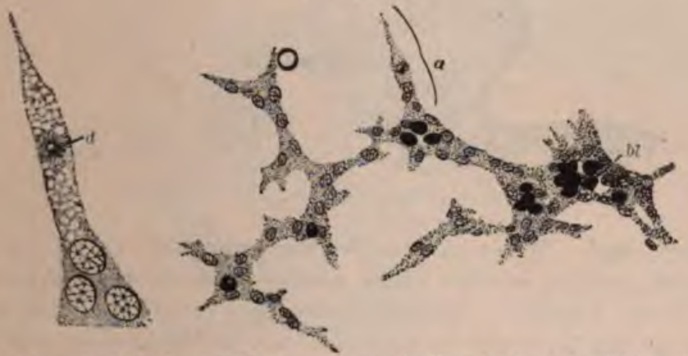
[1] Balfour: *Comp. Embryol.*, vol. ii. p. 519.

The larger trunks have been shown to commence in some invertebrates as solid cords of cells; the central cells become corpuscles, and the peripheral form the coats of the vessel. This mode of origin has not yet been proved to occur in vertebrates: the main arteries and veins possibly arise as mere clefts, the lining cells of which subsequently become modified to form the vascular walls.

FIG. 105.



Part of a Network of Developing Blood-vessels from the Vascular Area of a Guinea-pig (from Schäfer): *bl*, blood-corpuscles becoming free in an enlarged and hollowed part of a network of mesoblast cells. The smaller figure, to the left, represents *a* of the larger figure more magnified; *d*, a dividing nucleus.

*The Development of the Heart.*—The mammalian heart commences as a pair of tubular clefts in the mesoblast of the head region of the embryo. These tubes (*a*, Fig. 106) lie at first on the sides of that part of the medullary groove which will ultimately form the hind- and mid-brains. They appear before the medullary groove has closed and while the blastoderm has not been folded in to enclose the pharyngeal cavity on the ventral side. The head-fold (p. 112) has not yet arisen, its appearance in Mammalia being comparatively late. As the blastoderm tucks-in from each side to mark off the under surface of the head-fold and enclose the pharynx, the paired hearts are brought nearer

FIG. 106.

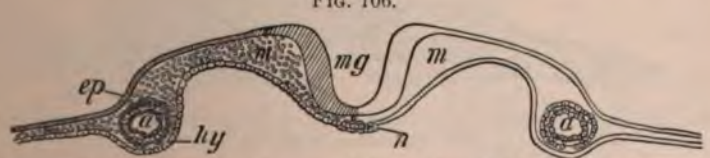


Diagram: *a*, cavity of primitive heart surrounded by an inner (endothelial) and outer (muscular) layer of mesoblast cells: the cells of these layers are united by branches; *hy*, hypoblast; *ep*, epiblast; *m*, mesoblast; *mg*, medullary groove; *n*, thickening of hypoblast to form the commencement of the notochord.

together (Fig. 107). Next (Fig. 108) they come into almost immediate contact in the middle line, beneath the anterior part of the alimentary canal. Meanwhile, the forward growth of the head and the increasing tucking-in from before backward of the under curve (Fig. 40) of the head-fold, shift the heart backward in relation to the brain so that it comes to lie under the mid-brain (Fig. 109). At this time the pleuroperitoneal cavity has appeared: its anterior portion divides into right and left extensions, and these branches, growing forward, partially enclose (*pp*, Figs. 108, 109) the developing heart. From them the pericardiac cavity is afterward formed. Later still, as the neck develops, the heart is shifted farther back in relation to the brain; it lies in the anterior part of the pleuroperitoneal cavity, attached to the under side of the alimentary tube, and in a position just above the letters *pp* in Fig. 40. Immediately in front of it is the uncleft mesoblast of the neck, which, as has already been stated, never cleaves into somatic and splanchnopleuric layers.

FIG. 107.

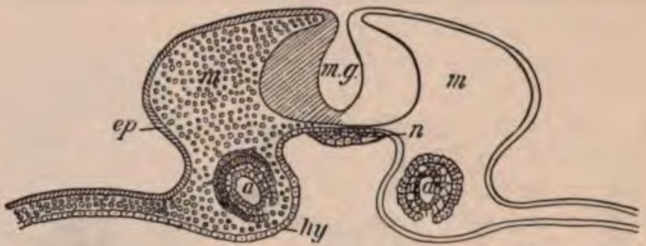


Diagram. The letters of reference are as in Fig. 106.

FIG. 108.

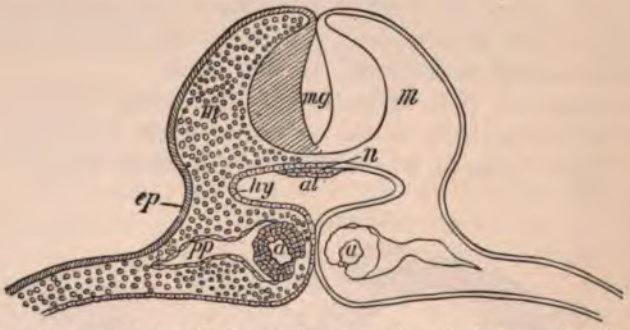
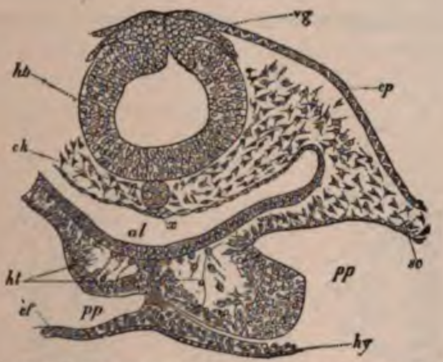


Diagram: *pp*, anterior extension of pleuroperitoneal cavity; *al*, pharynx: the other letters of reference are as in Fig. 106.

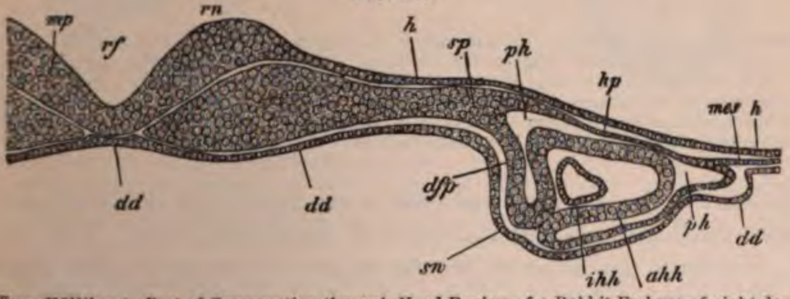
Soon after the first appearance of the primary cardiac cavities the cells immediately surrounding them (Fig. 106) form a special layer, which is the beginning of the endothelium of the heart. Cells external to this also differentiate and multiply (Figs. 106, 107, 108); they ultimately form the myocardium. A space exists for some time (Figs. 106, 107) between the cardiac endothelium and the primitive myocardium; but it is traversed by branches from the cells of these two layers, or, more probably, is occupied by branched mesoblastic cells which develop later into the connective-tissue stratum of the endocardium. In Fig. 110 this stage is represented, though the figure is defective, inasmuch as it does not indicate the stratum lying between and uniting the endocardium and myocardium.

FIG. 109.



(From Balfour.) Transverse Section through Posterior Part of the Head of a Chick after thirty hours' incubation. On account of the relatively later formation of the head-fold in mammals, the relation of parts exhibited in the section answers to a later stage of mammalian as compared with avian development. *hb*, hind-brain; *vg*, origin of pneumogastric nerve; *ch*, notochord; *al*, pharynx; *ht*, heart; *pp*, pleuroperitoneal cavity; *so*, somatic layer of meso blast; *st*, splanchnic layer of mesoblast; *hy*, hypoblast.

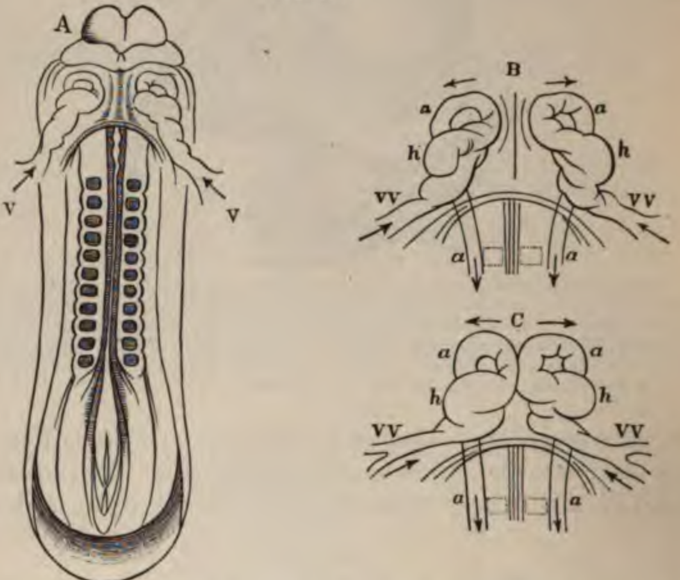
FIG. 110.



(From Kölliker.) Part of Cross-section through Head Region of a Rabbit Embryo of eight days and fourteen hours: *rf*, medullary groove; *mp*, epiblast of medullary groove; *h*, external epiblast; *hp*, somatic layer of mesoblast; *dfp*, splanchnic layer of mesoblast, continuous with the myocardium, *ahh*; *ihh*, cardiac endothelium; *ph*, front end of pleuroperitoneal cavity; *mes*, uncleft mesoblast, external to the heart; *sw*, wall of developing pharynx; *dd*, developing notochord.

The primary mammalian hearts are at first simple straight tubes. Each receives at its posterior extremity a vitelline vein, and pumps out blood anteriorly into the aorta. The aortæ pass forward into the neck mesoblast, and there turn dorsally: near the notochord they curve backward and run side by side toward the posterior end of the embryo. The hearts quickly become curved, and also exhibit (Fig. 111) dilatations at intervals; the most posterior dilatations, into which the vitelline veins, VV, open, are the rudiments of the auricles; these are succeeded by (*h*) swellings which indicate the commencing ventricles.

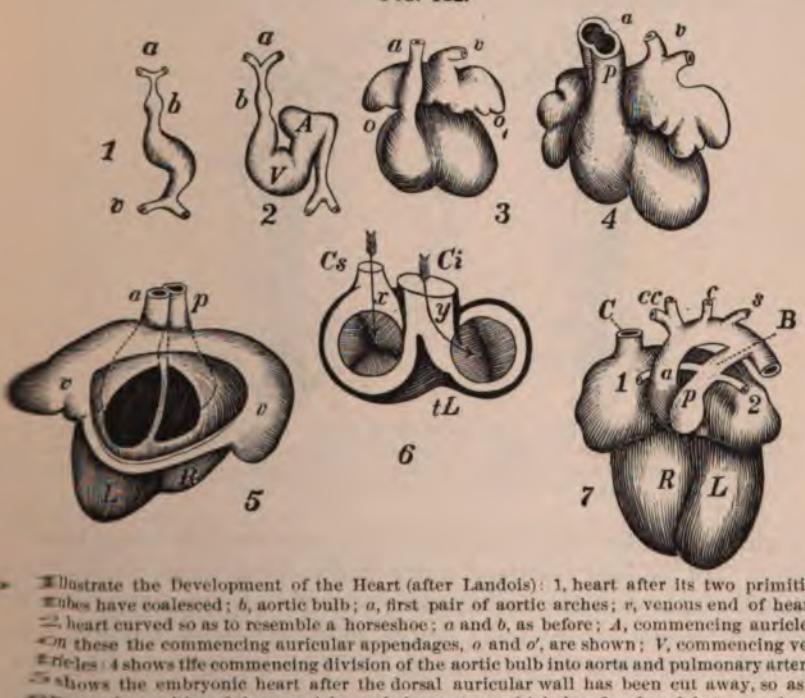
FIG. 111.



Embryo Rabbit of nine days and three hours, showing the commencing heart in two stages (after Allen Thomson; magnified 22 diameters): A, ventral view of the embryo, whose heart is represented in more detail in B; C, diagram of the heart of a slightly older rabbit embryo, in which the two halves of the heart have come into contact and commenced to coalesce; *h*, rudiment of the ventricle; *a*, primitive aortic arch and descending aorta; VV, vitelline veins entering the heart from behind. The arrows indicate the course of the blood.

The two hearts next meet and fuse in the middle line, and their cavities become continuous by absorption of the partition-walls. Fig. 112, 1, illustrates the structure of the organ at this stage. The single median tubular heart is now fixed anteriorly by its arterial and posteriorly by its venous connection, and exhibits a dilatation, *b*, where the aortæ arise from it; this dilatation is the *aortic bulb*. The vitelline veins have also joined one another near the heart to form the *venous sinus*. The middle part of the heart becomes free and bulges out on the under side of the throat (Fig. 113), and the whole organ becomes somewhat horseshoe-shaped. As this change in form occurs, the primitive posterior or venous end of the heart becomes pushed dorsally (A, 2, Fig. 112), in reference to the ventricular portion, V: from it the auricles (3, 4, Fig. 112) grow out on each side. About the fourth or fifth week in the human embryo the septum between the ventricles commences to develop (5, Fig. 112). A little later the portion of the aortic bulb nearest the ventricles becomes divided by a cross-septum which ultimately fuses with the ventricular partition; it separates the root of the pulmonary artery from the aorta, but until after birth the two vessels meet at a short distance from the heart (B, Fig. 112, 7). The auricular septum appears later (eighth week) than the ventricular, and remains incomplete until after birth, so as to allow the two auricles to communicate through the *foramen ovale*. The venous sinus has meanwhile largely been absorbed into the developing auricles, and what remains of it forms, close to the heart, three large vessels—the inferior and a right and left superior vena cava (p. 178). The inferior cava opens into the auricle on the right side of the septum, close behind the foramen ovale; about the eleventh week the Eustachian valve appears on the right side of its orifice, lying between it and the aperture of the left superior cava (=*coronary sinus* of the adult). This valve is so

FIG. 112.

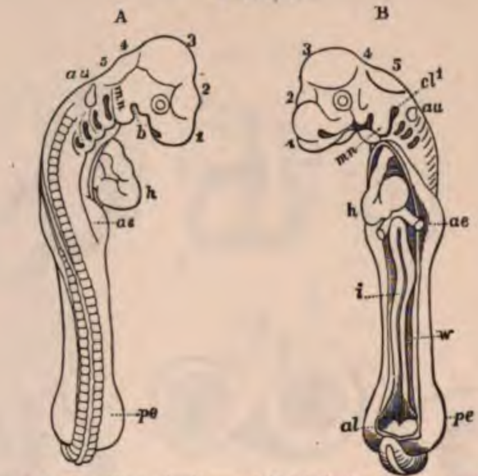


To illustrate the Development of the Heart (after Landois): 1, heart after its two primitive tubes have coalesced; *b*, aortic bulb; *a*, first pair of aortic arches; *v*, venous end of heart; 2, heart curved so as to resemble a horseshoe; *a* and *b*, as before; *A*, commencing auricles; on these the commencing auricular appendages, *o* and *o'*, are shown; *V*, commencing ventricles: 4 shows the commencing division of the aortic bulb into aorta and pulmonary artery; 5 shows the embryonic heart after the dorsal auricular wall has been cut away, so as to expose the cavities of the ventricles and the septum which has developed between them; 6 indicates the direction of the venous blood, from the superior cava, *Cs*, into the right ventricle, and from the inferior cava, *Ci*, into the left auricle; 7, heart of fœtus at term; *R*, right, *L*, left ventricle; *a*, aorta and (*cc*, *c*, *s*) the branches from its arch; *B*, ductus arteriosus (*ductus Botalli*); *p*, pulmonary artery, and 1 and 2, its small branches to the lungs.

placed as to aid in directing blood from the inferior cava into the left auricle, and blood from the upper cavæ into the right ventricle.

The primitive auricular septum springs from the ventral side of the auricular cavity, and falls short of reaching the dorsal side, so as to leave the foramen ovale open. About the eleventh week another auricular septum springs from the dorsal side, extends ventrally, and overlaps the primary septum, lying on its left side. It never becomes large, and until after the middle of fœtal life does not even become wide enough to cover the whole foramen ovale, over which it hangs like a curtain. In the later months of intra-uterine life it hangs beyond the aperture of the foramen, and forms a sort of valve: pressure on its right will separate it from the proper auricular septum and open the foramen ovale, while pressure on its left side will have the contrary effect. In the days immediately succeeding birth it gradually adheres to the auricular septum, and closes the aperture of communication between the auricles.[1]

FIG. 113.



(From Allen Thomson, after His.) Outlines of Chick Embryo at the end of the third day of incubation: A, dorsal and right sides; B, ventral and left sides; 1 to 5, vesicles of the brain; *b*, mouth; *mn*, inferior maxillary plate: behind it are the four visceral clefts; *ae*, rudiment of fore limb; *pe*, rudiment of hind limb; *au*, auditory pit; *h*, heart.

*Development of the Arteries.*—The aortic bulb, passing forward (after the two halves of the heart have fused in the middle line to form a single tube, and the whole organ has shifted back to the position on the under side of the somatopleure and just above the letters *pp* in Fig. 40), enters the uncleft mesoblast of the developing neck. Here it gives rise to the first pair of aortic arches: these turn dorsally on the sides of the throat, and when they reach the region of the notochord turn backward and run as a pair of *dorsal aortæ* toward the tail end of the embryo (*A*, Fig. 114). The two dorsal aortæ are shown in cross-section in several preceding figures (67 and 69): they soon meet behind the heart and fuse into a single tube (*B*, Fig. 114), the permanent dorsal aorta. At first the main branches of the aorta are the vitelline arteries (6), which carry blood to the vascular area of the yelk-sac, and beyond the origin of these branches they are much reduced (5′) in size. Most of the blood thus goes at first to the umbilical vesicle, from which it is returned to the heart by the vitelline veins. As the umbilical vesicle rapidly diminishes, less and less blood is sent to it, and the vitelline arteries become insignificant. The parts of the aortæ behind them become larger and convey more blood, and their fusion is carried farther back, so as to extend into the pelvic region and form what will become the middle sacral artery of the adult. Meanwhile, however, the posterior limbs and allantois have been developing, and the dorsal aorta gives off great branches on each side (common iliac), arteries which carry blood to those parts. The allantoic (umbilical) arteries are branches of the iliac: after birth they become impervious from the umbilicus as far back as the side of the bladder. The internal iliac and superior vesical arteries are remnants of the proximal portions of the allantoic arteries.

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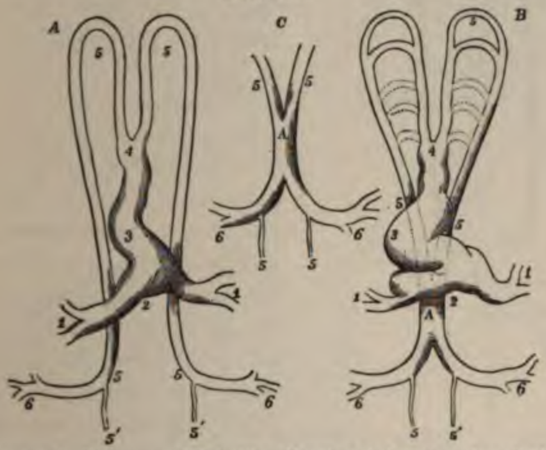
[1] For a good account of the structure and development of the auricular septum see Henle, *Anatomie des Menschen*, vol. ii.

FIG. 114.



(From Allen Thomson.) Diagrams of Primitive Heart and Arteries of an Embryo Chick: *A*, soon after the first establishment of the circulation; *B*, *C*, at a somewhat later period; 1, vitelline veins returning from vascular area; 2, 3, 4, the heart; 5 (above), first aortic arch; 5 (below), dorsal aorta; in *B* and *C* the two primitive aortæ are shown partially united to form the permanent dorsal aorta; 6, vitelline or omphalo-meseraic artery; 5, continuation of aorta beyond the origin of the vitelline artery.

As the neck elongates the aortic bulb becomes lengthened, and gives off successively a second, third, fourth, and fifth pair of arches behind the first pair and running around the pharynx to open into the dorsal aortæ. The second pair of these is represented in *B*, Fig. 114, and the three others are indicated by dotted lines. All the aortic arches are really branchial arteries, and correspond to those permanent vessels in fishes which convey blood to the gills and from the gills to the aorta: in air-breathing vertebrates they are for the most part transient structures and disappear before birth. The embryonic vascular system, with all the aortic arches developed, is represented in Fig. 115. The second and third pairs of arches, however, disappear for the most part before the fourth and fifth appear, so that at no single stage of development would all the arches be present as represented in the figure.

FIG. 115.

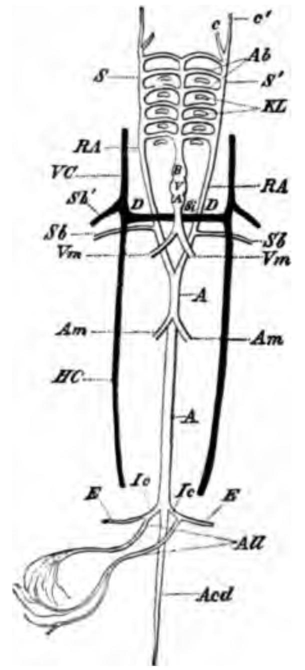
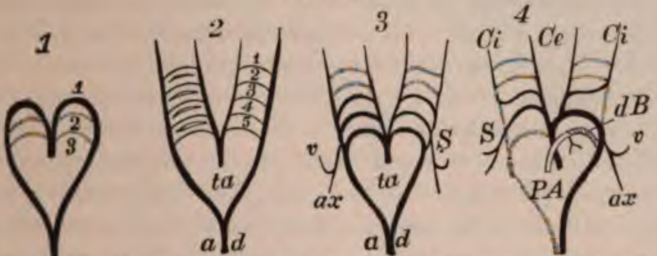


Diagram of Embryonic Vascular System of a Higher Mammal, at an early stage (from Wiedersheim): *A*, *A*, dorsal aorta; *RA*, its right and left roots connected by the branchial vessels (aortic arches) with the vessels *S*, *S'*; which correspond to the branchial veins of fishes: *c*, *c'*, internal and external carotids; *KL*, visceral (gill) clefts; *Si*, venous sinus; *A*, *V*, *B*, heart; *Vm*, vitelline veins; *Am*, vitelline arteries; *Ic*, common iliac artery; E, external iliac; *All*, allantoic (hypogastric) arteries; *Acd*, middle sacral artery; *VC*, *HC*, anterior and posterior cardinal veins; *Sb'*, subclavian vein; D, anterior vena cava (duct of Cuvier), opening into venous sinus.

The ultimate fate of the various aortic arches of the mammal is shown in Figs. 116 and 117. The middle portions (3, Fig. 116) of the first and second arches disappear: their inner and outer ends remain as the rudiments of the internal and external carotid arteries (*Ci*, *Ce*, 4, Fig. 116), and grow forward into the head. As is clear from the figures, they are supplied with blood from the third arch and from the main stem connecting it with the fourth arch; this stem elongates as the neck increases in length, and becomes the common carotid. The fourth arch on the right side becomes the subclavian. The fourth arch on the left side develops into the permanent aortic arch, and gives off the left subclavian as a branch. The fifth arch on the right side disappears, as do also its dorsal connections with the fourth arch in front of it and with the dorsal aorta behind. The fifth arch on the left side remains until birth as a large trunk (ductus arteriosus, ductus Botalli) opening into the stem leading from the fourth left arch to the dorsal aorta. It gives off two branches (right and left pulmonary) which go to the lungs. Soon after birth the portion of the left fifth arch which lies beyond the pulmonary branches dwindles, and in a few days it becomes an impervious cord, the *ligamentum arteriosum:* its pulmonary branches greatly enlarge, and its proximal portion remains throughout life as the stump of the pulmonary artery.

FIG. 116.



Diagrams to illustrate the Development of the Aortic Arches (from Landois): 1, the first three pairs of arches, the first pair only fully developed; 2, the five pairs of aortic arches; *ta*, bulbus arteriosus; *ad*, dorsal aorta; 3, stage when the greater portion of the first and second arches has become obliterated; *S*, left subclavian artery; *v*, right vertebral artery; *ax*, right axillary artery; 4, transition to the final stage; *P*, pulmonary artery; *A*, aorta; *S*, right subclavian, continuous with the fourth arch on that side and with the origin of the common carotid; *Ci* and *Ce*, internal and external carotids; *dB*, ductus arteriosus; *v* and *ax*, respectively, the vertebral and axillary arteries of the left side.

FIG. 117.

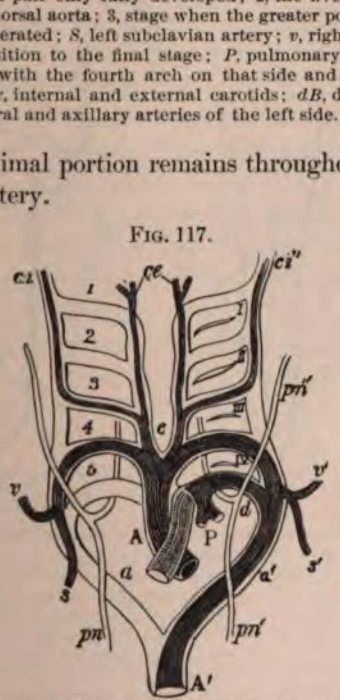
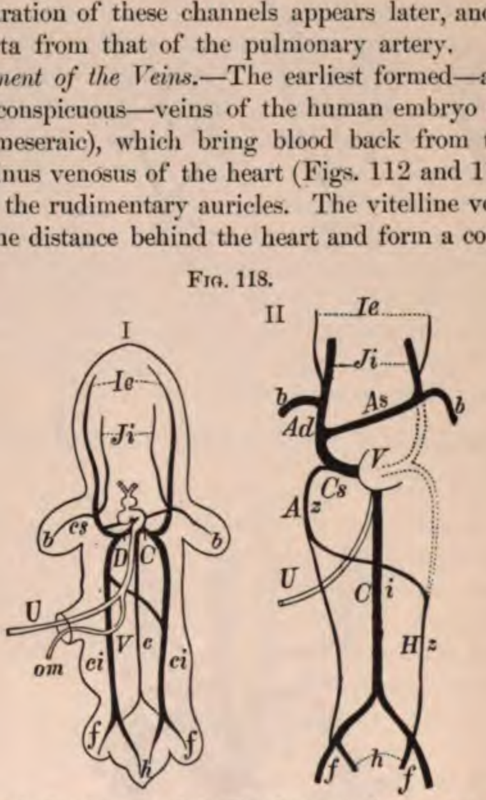


Diagram showing the Primitive Aortic Arches of the Mammal, with their transformations (from Allen Thomson, after Rathke): A, P, primitive aortic bulb, now divided into ascending part of aortic arch, A, and the root of the pulmonary arteries, P; *a*, *a'*, primitive union of aortic arches to form the permanent dorsal aorta, A'; 1, 2, 3, 4, 5, the primitive aortic arches; I, II, III, IV, the branchial (pharyngeal) clefts, omitted on the opposite side for the sake of clearness. The permanent systemic vessels are represented in deep shading, the pulmonary system in lighter shading, and parts of the original arches which are purely temporary are only indicated in outline. *c* lies between the origins of the common carotids; *ci*, *ci'*, internal carotids; *ce*, external carotids; *s*, right subclavian; *v*, right vertebral; *s'* and *v'*, left subclavian and vertebral; P, right and left pulmonary arteries; *d*, ductus arteriosus; *pn*, *pn'*, pneumogastric nerves, illustrating the relationships of their recurrent branches to the primitive and permanent aortic arches.

Long before birth, and while some of the earlier changes of the aortic arches above described are occurring, the septum of the aortic bulb (Fig. 112) has commenced. It divides the cavity of the bulb into two channels, one of which communicates with the fourth pair of arches, the other opens into the fifth. The external constriction indicating the separation of these channels appears later, and divides the root of the aorta from that of the pulmonary artery.

*The Development of the Veins.*—The earliest formed—and, for some time, the most conspicuous—veins of the human embryo are the vitelline (omphalo-meseraic), which bring blood back from the umbilical vesicle to the sinus venosus of the heart (Figs. 112 and 114), which in turn opens into the rudimentary auricles. The vitelline veins soon fuse together for some distance behind the heart and form a common trunk, the *meatus venosus:* the right one soon disappears, or at least becomes so reduced in relative size that it appears a mere tributary branch of the left.

FIG. 118.



Diagrams illustrating the Development of the First Important Veins, except the vitelline and allantoic: *Ie*, anterior cardinal vein, subsequently the external jugular; *Ji*, internal jugular; *b*, subclavian vein; *Dc*, ducts of Cuvier, which become on the right side the superior cava, on the left the coronary sinus; *Ad*, right innominate vein; *As*, cross-branch, which becomes the left innominate vein; *U* and *om*, vitelline veins; in I the left, *U*, is indicated as already larger than the right, *om;* in II the right has entirely disappeared. In I, *ci*, *ci*, the posterior cardinal veins, and *Vc*, the commencing inferior cava; in II, *Ci*, the inferior cava. In both I and II, *f*, external iliac, and *h*, hypogastric vein; in II, *Az*, azygos vein; *Hz*, hemiazygos vein. (From Landois.)

The first important veins arising within the body of the embryo are the *cardinal* veins (Fig. 118, I), an anterior and a posterior on each side: the anterior and posterior vessels unite, and from their point of junction a short cross-branch, the Cuvierian duct (Figs. 115 and 118) is given off and opens into the venous end of the heart: the Cuvierian ducts are the rudiments of the right and left superior cavæ.

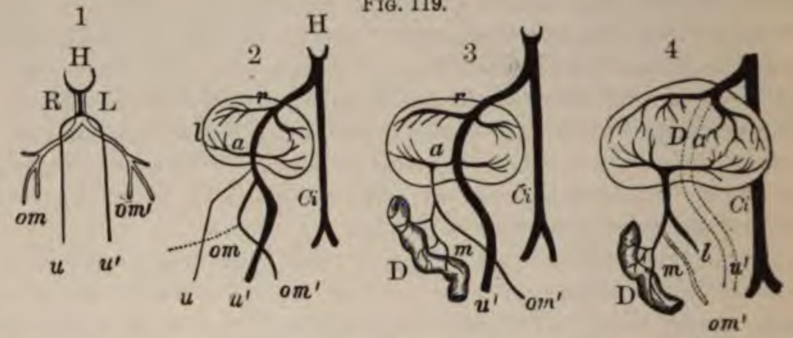
Each anterior cardinal gives off an internal jugular (*Ji*, Fig. 118) and a subclavian (*b*, Fig. 118) branch: its main stem remains for a time conspicuous as the external jugular (*Ie*, I, Fig. 118), but subsequently in the human embryo becomes much diminished in relative size as compared with the internal jugular (II, Fig. 118). A transverse anastomosing branch, running obliquely downward from the left to the right anterior cardinal vein, also develops. This cross-branch rapidly increases in size (*As*, II, Fig. 118), and forms ultimately the left innominate vein: nearly all the left anterior cardinal vein below the origin of this branch disappears, so that its blood is carried to the right vein, the part of which below the point of anastomosis with the left innominate is known in human anatomy as the right innominate vein (*Ad*, II, Fig. 118). A part of the lower portion of the left cardinal (or left anterior cava) immediately dorsal to the heart remains pervious and constitutes the coronary sinus of the adult.

The posterior cardinals are at first the only veins which bring back blood from the posterior part of the embryo and from the kidneys. Each divides posteriorly into a hypogastric and an external iliac vein (*h* and *f*, Fig. 118). The inferior cava (*Vc*, Fig. 118, I) is at first very small, and arises by two branches from the points of bifurcation of the posterior cardinal veins. The latter veins are also united by a cross-branch. Ultimately, the inferior cava and its roots, and the hypogastric and iliac veins, enlarge very much (Fig. 118, II). The right cardinal vein remains as the *vena azygos* (*Az*), while the upper part of the left disappears, and its lower part and the cross-branch persists as the *vena hemiazygos*, or the small azygos vein (*Hz*, Fig. 118, II).

The vitelline veins, as already pointed out, open at first into the venous end of the primitive tubular heart (Figs. 115 and 119), and soon fuse for some distance behind the heart to form the meatus venosus; while the left grows so much faster than the right that the latter comes to be a mere branch of the former. The inferior cava as soon as it is formed opens anteriorly into the meatus venosus (2, Fig. 119). The umbilical veins develop with the establishment of the placental circulation (about the fourth week), and (*u*, *u′*) open also into the meatus venosus. They are at first smaller than the vitelline veins, but with the dwindling of the umbilical vesicle and the growth of the placenta they become larger; the right one (*u*) soon atrophies, but the left (*u′*) remains as the great umbilical vein until birth.

The umbilical vesicle (Figs. 55 and 56) being an outgrowth of the splanchnopleure, as is also the heart essentially, its veins run, of course, in the mesoblastic layer of the splanchnopleure to the heart. The portions of the splanchnopleure next the embryo form (p. 186) most of the alimentary canal, and veins from this region of it appear as the alimentary tube is closed in. They join the umbilical vein near its entry into the meatus venosus, and are at first insignificant in size. But as stomach, intestines, liver, pancreas, and spleen develop, and the umbilical vesicle shrivels, the veins from the alimentary tube and its dependencies come to be more and more conspicuous, and the vitelline veins to be of less relative size and importance. In this way it comes

FIG. 119.



Development of Some of the Veins (from Landois): H, heart; R and L, respectively, the right and left sides of the body; *om* and *om′*, right and left vitelline veins; *u* and *u′*, the right and left allantoic veins; *Ci*, inferior cava; D, intestine; *m*, mesenteric veins; *a*, venæ advehentes; *r*, venæ revehentes; *l*, splenic vein; *Da*, remnant of ductus venosus, forming the round ligament of the liver.

about that the veins of the "chylopoietic" viscera become much more important than those of the yelk-sac (umbilical vesicle): they ultimately form the portal system.

The liver (p. 188) is an outgrowth from the embryonic portion of the splanchnopleure, and develops around the meatus venosus (2, Fig. 119). The conjoined vitelline (*om′*) and allantoic (umbilical) veins (*u′*) pass through it on their way to the meatus venosus, which by this time is no larger than the inferior cava. The part of the meatus which lies in contact with the liver is known as the *ductus venosus*. It gives off branches (the venæ advehentes, *a*, Fig. 119, 2 and 3) to the liver, and these branches end in capillaries which unite to form the *venæ revehentes* (*r*), which are the rudiments of the hepatic veins. Blood returning from the placenta by the umbilical vein (*u′*, 2 and 3, Fig. 119), from the umbilical vesicle by the vitelline vein (*om′*), and from the alimentary canal by the roots (*m*) of the mesenteric, gastric, and splenic veins, may reach the heart either directly through the ductus venosus, or indirectly through the advehent and revehent (hepatic) veins. After birth (see 4, Fig. 119) the vitelline vein (*om′*) disappears; the allantoic or umbilical vein (*u′*) also becomes obliterated, its remnant in extra-uterine life being a fibrous cord known as the *round ligament* of the liver. Thus after birth the only venous blood reaching the liver comes from the gastric, splenic, pancreatic, and mesenteric veins, which unite to form the *portal vein.*[1]

*The Fœtal Circulation in the Last Stage of Pregnancy.*—It is obvious from statements made in the preceding pages that the fœtal circulation varies greatly at different periods of embryonic development. There is a first stage, during which the circulation through the walls of the umbilical vesicle is the most important; this soon gives way to a second stage, in which the placental (allantoic) circulation is predominant. As the embryo increases in size and its limbs develop, the circulation within the body proper of the embryo becomes relatively more and more important, and the condition existing in the last weeks preceding birth may justifiably be named a third stage, which is modified after parturition into the extra-uterine or fourth stage.

The fœtal circulation in the third stage is represented in Fig. 120, drawn by Allen Thomson, from whom also is taken the following account of the circulation at birth and the changes in it which soon follow birth:

FIG. 120.

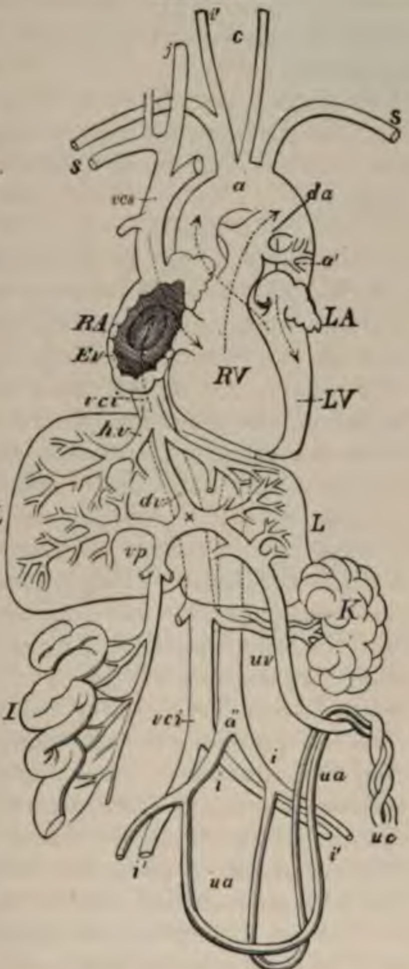


Diagram of the Circulatory Organs of the Human Fœtus at Six Months (Allen Thomson): *RA*, right auricle; *RV*, right ventricle; *LA*, left auricle; *Ev*, Eustachian valve; *L*, liver; *K*, left kidney; *I*, part of small intestine; *a*, aortic arch; *a'*, its dorsal part; *a''*, posterior end of abdominal aorta; *vcs*, superior vena cava; *vci*, inferior vena cava near its junction with the right auricle; *vci'*, posterior part of inferior cava; *s*, subclavian vessels; *j*, right jugular vein; *c*, common carotid arteries; the four dotted arrow-lines indicate the course of the circulation; *da*, ductus arteriosus; an arrow-line starting at *vci* indicates the course of blood-flow from the inferior cava through the foramen ovale; *hv*, hepatic veins; *vp*, vena portæ; *x* to *vci*, the ductus venosus; *uv*, umbilical vein; *ua*, umbilical arteries; *uc*, umbilical cord; *i*, *i'*, iliac vessels.

"The *foramen ovale* retains the form of a free oval opening in the septum auricularum up to the fourth month, but in the course of that month and the next the valvular plate or curtain [see p. 174] which [lies on the left side] of the fossa ovalis becomes complete, so that in the last three and a half months the blood can only pass from the right into the left auricle, but not in a contrary direction.

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[1] Even among the higher mammals the development of the great veins varies considerably: the statements given in the text must therefore be considered as applying only to the human embryo.

"The *Eustachian valve* constitutes a crescentic fold of the lining membrane of the heart, which is so situated as to direct the blood entering the auricle by the inferior cava toward the opening of the foramen ovale.

"The *ductus arteriosus* (Figs. 112 and 117) establishes a connection between the main pulmonary artery and the aorta, by which the blood from the right ventricle is carried mainly into the dorsal aorta.

"The two large hypogastric or umbilical arteries, prolonged from the iliac arteries, passing out of the body of the fœtus, proceed along the umbilical cord to be distributed in the fœtal portion of the placenta. From the placenta the blood is returned by the umbilical vein, which, after entering the abdomen, communicates by one branch with the portal vein of the liver, and is continued by another, named the *ductus venosus*, into . . . . the main stem of the vena cava inferior.

"The right auricle of the fœtal heart [at this stage] receives blood from the two [upper and lower] venæ cavæ and the coronary vein. The blood brought by the superior cava is simply the venous blood returned from the head and upper part of the body; whilst the inferior cava, which is considerably larger than the superior, conveys not only the blood from the lower half of the body, but also that which is returned from the placenta and from the liver. This latter stream of blood reaches the vena cava inferior partly by a direct passage—the *ductus venosus*—and partly by the hepatic veins, which bring to the vena cava inferior all the blood circulating through the liver, whether derived from the supply of placental blood entering that organ by the umbilical vein or proceeding from the vena portæ or hepatic artery.

"The blood of the superior vena cava, passing from the right auricle into the right ventricle, is thence propelled into the trunk of the pulmonary artery. A small part of it is distributed through the branches of that vessel to the lungs, and returns by the pulmonary veins to the left auricle; but, as these vessels remain comparatively undilated up to the time of birth, by far the larger part passes through the ductus arteriosus into the dorsal aorta, and is thence distributed in part to the lower half of the body and its viscera, and in part is conveyed along the umbilical arteries to the placenta. From these several organs it is returned by the vena cava inferior, the vena portæ, and the umbilical vein, and, as already noticed, reaches the right auricle through the trunk of the inferior cava.

"Of the blood entering the heart by the inferior vena cava, only a small part is mingled with that of the superior cava, so as to pass into the right ventricle; by far the larger portion, directed by the Eustachian valve through the foramen ovale, flows into the left auricle, and thence, together with the small quantity of blood returned from the lungs by the pulmonary veins, passes into the left ventricle, whence it is sent into the arch of the aorta to be distributed almost entirely to the head and upper limbs."

*Changes in the Circulation at Birth.*—"The changes which occur in the organs of circulation and respiration at birth, and which lead to the establishment of their permanent condition, are more immediately determined by the inflation of the lungs with air in the first respiration, the accompanying rapid dilatation of the pulmonary blood-vessels with a greater quantity of blood, and the interruption to the passage of blood through the placental circulation. These changes are speedily followed by shrinking and obliteration of the ductus arteriosus in the space between the divisions of the right and left pulmonary arteries and its junction with the aorta, and of the umbilical arteries from the hypogastric trunk to the place of their issue from the body by the umbilical cord; by the cessation of the passage of blood through the foramen ovale; and, somewhat later, by the closure of that foramen and by the obliteration of the umbilical vein as far as its entrance into the liver, and of the ductus venosus within that organ.

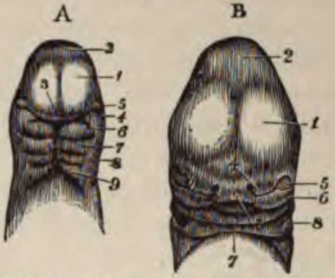
"The process of obliteration of the arteries appears to depend at first mainly on the contraction of their coats; but this is very soon followed by a considerable thickening of their substance, reducing rapidly their internal passage to a narrow tube, and leading in a short time to final closure, even although the vessel may not present externally any considerable diminution of its diameter. It commences at birth, and is perceptible after a few respirations have occurred. It makes rapid progress in the first and second days, and by the third or fourth day the passage through the umbilical arteries is usually completely interrupted. The ductus arteriosus is rarely found open after the eighth or tenth day, and by three weeks it has in almost all instances become completely impervious.

"The process of closure in the veins is slower, there not being the same thickening or contraction of their coats; but they remain empty of blood and collapsed, and by the sixth or seventh day are generally closed.

"Although blood ceases at once to pass through the foramen ovale from the moment of birth, or as soon as the left auricle becomes filled with the blood returning from the lungs and the pressure within the two auricles is equalized, yet the actual closure of the foramen is more tardy than any of the other changes now referred to. It is gradually effected by the union of the fore part of the valvular fold [or curtain on the left side] of the fossa ovalis with the margin of the annulus; but the crescentic margin is generally perceptible in the left auricle as a free border beyond the place of union, and not unfrequently the union remains incomplete, so that a probe may be passed through the reduced aperture. In many cases a wider aperture remains for more or less of the first year of infancy, and in certain instances there is such a failure of the union of the valve as to allow of the continued passage of venous blood, especially when the circulation is disturbed by over-exertion, from the right to the left auricle, as occurs in the malformation [causing] the morbus cœruleus."

*The Visceral Arches and Clefts.*—Closely connected in developmental history with the aortic arches are certain structures known as the visceral, or branchial, arches and clefts. These are primarily four pairs of slits on the sides of the neck, which in fishes and many amphibia remain throughout life as the gill-clefts extending from the exterior surface to the pharyngeal cavity. According to recent investigations, these slits are imperfect in the embryos of existing birds and mammals, being closed by a thin membrane. The first to appear is the most anterior, and the others follow in regular order: in a human embryo of three weeks three pairs of the gill-clefts are present, and very soon the fourth appears (Fig. 121, A). The front edge of each cleft grows out into a prominent ridge, the visceral or branchial arch, as does ultimately the posterior edge of the hindmost slit: there are therefore five arches on each side. The aortic arches run at first in the corresponding branchial arches. In man the clefts very soon are obliterated (during the second month) except the first, of which the external auditory meatus, the tympanic cavity, and the Eustachian tube are modified remnants. In the

Fig. 121.



(From Quain's *Anatomy*, after Ecker.) A, from a human embryo of about three weeks: 1, cerebral vesicle or developing cerebral hemisphere; 2, the inter-brain or diencephalon; 3, frontal process; 4, superior maxillary plate; 5, eye; 6, inferior maxillary plate; 7, second branchial arch; 8, third; 9, fourth: posterior to each of these is the corresponding visceral or branchial cleft.

B (from an embryo of about five weeks): 1, 2, 3, 5, as in A; 6, superior maxillary plate; 7, inferior maxillary; 8, outer part of first cleft, which becomes the external auditory meatus.

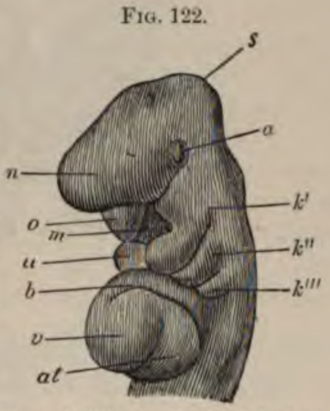
Beneath 3 in A is seen the aperture of the stomadæum.

first, second, and third arches skeletal structures develop which take part in the formation of the upper and lower jaws and of the hyoid.

The mouth, or rather the primitive bucco-nasal cavity, arises (p. 121) as a pit lined by epiblast, and ultimately opening into the anterior end of the primary alimentary canal: this pit is the stomadæum. The first pair of visceral arches (6, A, Fig. 121) lie on its posterior or lower side, and are known as the *inferior maxillary plates:* each of them gives off a process, 4, directed medially and forward—the *superior maxillary plate.*

Meanwhile, there has grown backward or downward from the head the *frontal process* (3, Fig. 121). It meets on each side a superior maxillary plate, and forms the upper boundary of the bucco-nasal cavity (Fig. 122). A side view of the head of a human embryo at this stage (about four weeks) is shown in Fig. 123. On each side of the frontal plate a pit (the *nasal pit, n,* Fig. 122) appears. From it a groove runs back; passing beneath the fused frontal and superior maxillary plates, it forms there a tube which opens into the stomadæum (Fig. 125). The primitive nostril-chamber of the embryonic mammal therefore opens directly into the front of the roof of the mouth—a condition which is permanent in the frog and many other animals. In the human embryo the subsequent development of the hard and soft palates divides the stomadæum into a buccal and a nasal part, and throws back to the pharynx the communication between the respiratory and alimentary tubes. In the human embryo the hard palate is closed about the ninth week, and a downgrowth from the frontal process above it forms the nasal septum. These normal transformations may not be completed: if the frontal process does not fuse with the superior maxillary plate, the mouth remains imperfectly separated from the nose: if the defective development affects only the soft parts, the result is hare-lip (single or double as the case may be); if it extends to the palatal plates of the superior maxillary and palatine bones, the result is cleft palate.

FIG. 122.



(From Kölliker.) Head of Embryo Rabbit of Ten Days: *a*, eye; *at*, auricular portion of heart; *b*, arterial bulb; *k'*, *k''*, *k'''*, first, second, and third visceral arches; *m*, stomadæum; *o*, superior maxillary process; *u*, inferior maxillary plate; *s*, diencephalon; *b*, region of cerebral vesicles; *v*, ventricular portion of heart.

In the inferior maxillary plate a cartilaginous rod (Meckel's cartilage) develops. Its upper end ossifies in mammals to form the malleus; most of the remainder is absorbed, the lower maxillary bone being developed mainly in membrane which surrounds the primitive cartilage.

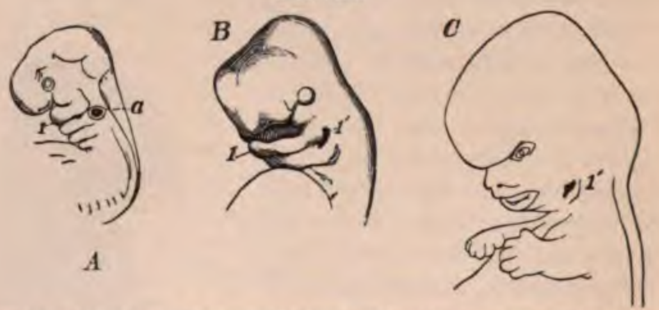
The ankylosis of the inferior maxillæ at the chin occurs toward the end of the first year of extra-uterine life.

The second visceral arch is known as the *hyoidean*, and develops a cartilaginous rod within it. This rod is connected above with the temporal bone, and gives rise to the styloid process, the stylo-hyoid ligament, and the small cornu of the hyoid bone. Whether the incus and stapes are derived from it or from the first arch is still doubtful.

The cartilages which develop in the third branchial arches give origin in man to the body and great cornua of the hyoid.

Of the cartilaginous skeleton of the fourth arch the thyroid cartilage is a modified remnant. The cartilage of the fifth arch disappears entirely in man. In vertebrates which breathe air dissolved in water it remains as a branchial arch, bearing gills, and has several others behind it.

FIG. 123.



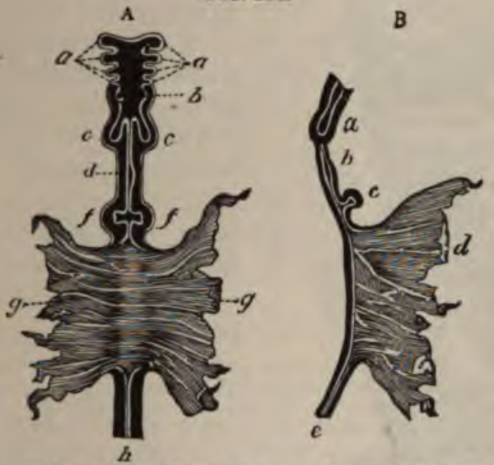
Profile View of Head and Neck of Human Embryo, of about four weeks (from Quain's *Anatomy*; magnified ten diameters): *a*, auditory pit; 1, inferior maxillary plate: following it are the second, third, and fourth visceral arches, and the branchial clefts separating them.

The condition known as *cervical fistula* is due to the imperfect closure of some one or other branchial cleft behind the first.

*The Development of the Alimentary Canal.*—The origin of the primitive alimentary canal, or *archenteron*, as a tube formed by infolding of the splanchnopleures has already been described, as also the continuity of its walls with those of the umbilical vesicle. To this archenteron are subsequently added an anterior portion (stomadæum) and a posterior (proctodæum); both of these are lined by epiblast and pitted in from the exterior (Figs. 43 and 57).

The archenteron soon shows a differentation into three regions: the part of it which lies originally within the head-fold is known as the *fore-gut*; from it the lungs, pharynx, gullet, stomach, and duodenum are derived. The posterior portion of the archenteron is short and lies within the tail-fold; most of the rectum is formed from it, as also the allantois and its derivatives (urinary bladder, etc.): it is named the *hind-gut.* The median portion of the archenteron remains for a considerable period open on its ventral side, where its walls spread apart to form the umbilical vesicle (Fig. 124). It is known as the *mid-gut* or *mesenteron,* and is at first relatively short: as it closes-in it elongates and forms the greater part of the small and large intestines.

FIG. 124.



(From Kölliker, after Bischoff.) The Alimentary Canal at an Early Stage. A, from the ventral side; B, in longitudinal section.

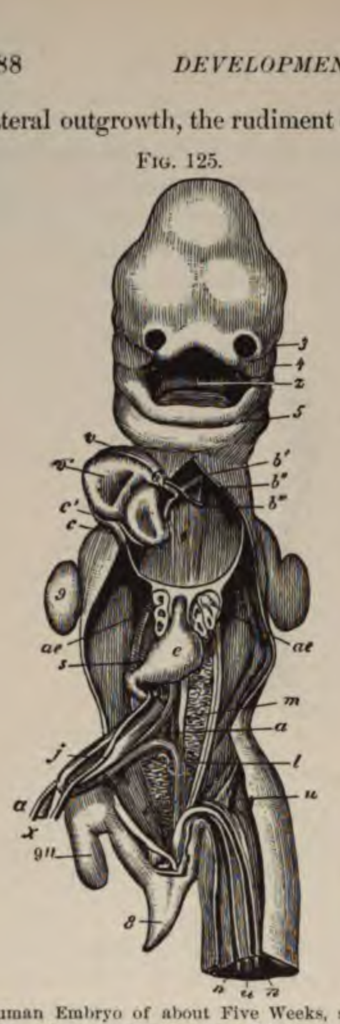
In A the letters *a* indicate four branchial clefts; *b*, the pharynx; *c,c*, the commencing lungs; *d*, the stomach; *f*, commencing liver; *g*, part of umbilical vesicle into which the mesenteron opens; *h*, hind-gut. In B, *a*, the commencing lungs; *b*, the stomach; *c*, the liver; *d*, proximal part of umbilical vesicle.

*The fore-gut* elongates as the embryo develops, and extends from the head to the abdominal region: part of it dilates quite early in development and forms the rudiment of the stomach (Fig. 125). Beyond the stomach it continues as the duodenum; from this portion the liver and pancreas are developed.

*The mid-gut*, where its aperture of communication (*ductus vitello-intestinalis*) with the umbilical vesicle narrows, is a nearly straight tube lying close under the vertebral column. As it elongates it forms loops which for the most part bend ventrally—that is, away from the region of the dorsal vertebræ. These loops, however, still remain attached to the mesoblast of the dorsal side of the abdominal cavity by a thin membrane, the rudiment of the mesentery, mesocolon, and so forth. The mesentery is represented in very diagrammatic form in Fig. 39: by comparison of this figure with others (36 and 69) it will easily be seen that the mesenteric folds are produced by a transverse thinning and a dorso-ventral increase of the original wide and short mesoblastic layer attaching the dorsal wall of the mid-gut to the somatic mesoblast.

The first-formed loop of the mesenteron is partly small, partly large intestine. The point of separation of the two is soon indicated by lateral outgrowth, the rudiment of the *cæcum*, which arises just posterior to the most projecting region of the loop. As the small intestine develops, the portion of it behind the duodenum becomes more and more coiled, and some of these coils (Fig. 127) lie at first in the proximal end of the umbilical cord: these are withdrawn into the abdominal cavity about the end of the third month.

FIG. 125.



Human Embryo of about Five Weeks, seen from the ventral side (from Kölliker, after Coste): 3, external nasal process of frontal process; 4, superior maxillary plate; 5, inferior maxillary plate; z, tongue; b, arterial bulb; b', third aortic arch; b'', fourth aortic arch; b''', fifth aortic arch; c, superior cava and right azygos veins; c', the sinus venosus; c'', the common stem of the left anterior vena cava and the left azygos vein; o', left auricle of heart; v, right auricle; v', left ventricle; ae, lungs; e, stomach; j, left umbilical vein; s, continuation of same behind the pylorus, which subsequently becomes the portal vein; x, vitello-intestinal duct; a, right umbilical artery; m, Wolffian body; l, rectum; n, allantoic artery; u, allantoic (umbilical) vein; 3, the tail, which is subsequently lost in the human embryo; 9, rudiment of fore limb; 9'', rudiment of hind limb. The placenta, the liver, and most of the umbilical vesicle have been removed from the embryo.

The large intestine is at first of less diameter than the small. The cæcum is at first a uniform tube lying in the proximal dilated portion of the cavity of the umbilical cord: its separation into cæcum proper and vermiform appendix occurs later.

*The hind-gut* not only gives origin to most of the rectum, but to the allantois and urinary bladder, and its development is so intimately connected with that of the external genito-urinary organs that it seems best to consider it in connection with them.

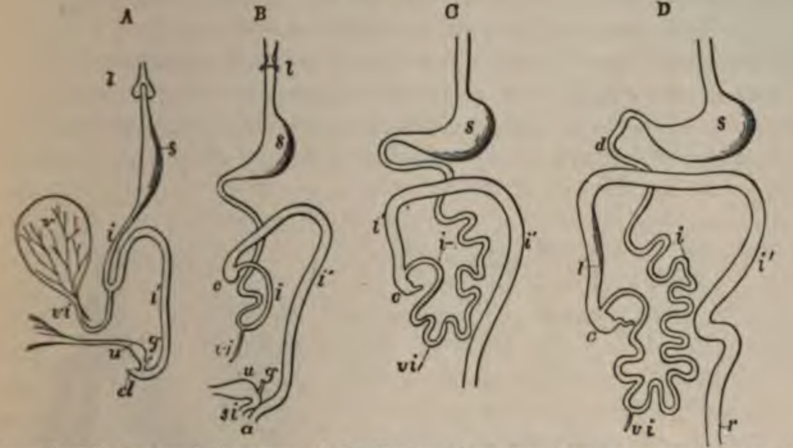
In Fig. 126 are diagrams illustrating the development of the alimentary canal and its structure at various stages.

The umbilical duct is at the third month normally a mere thread or cord attached to the ileum: sometimes its proximal end remains dilated throughout life as a diverticulum from the intestine.

The various forms of umbilical hernia are in general due to a greater or less persistence of fœtal stages in which part of the intestine extends into the umbilical cord (Fig. 127).

*The Development of the Liver.*—This organ arises as a thickening of the mesoblast layer of the duodenum. Into it there extends a pair of tubes opening into the alimentary canal and lined by hypoblast cells (Fig. 128). From these tubes, which are the primitive hepatic ducts, anastomosing cords of hypoblast burrow through the organ: they give rise to the true hepatic cells. The relation of the allantoic (umbilical),

FIG. 126.



(From Quain's *Anatomy*.) Diagrams of the Human Alimentary Canal at successive stages of development: A, from embryo of five weeks; B, from embryo of nine weeks; C, ten weeks; D, twelve weeks; *l*, lungs sprouting out from the pharynx; *s*, stomach; *d*, duodenum; *i*, small intestine; *i'*, large; *c*, cæcum and vermiform appendix; *r*, rectum; *cl*, in A, the cloaca; *a*, in B, the anus distinct from *si*, the urogenital sinus; *v*, the yelk-sac; *vi*, the vitello-intestinal duct; *u*, the urinary bladder and urachus leading to the placenta; *g*, the genital ducts. In B and C the diameter of the colon is erroneously represented as greater than that of the ileum.

FIG. 127.

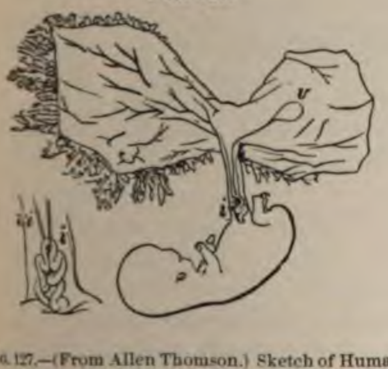


FIG. 128.

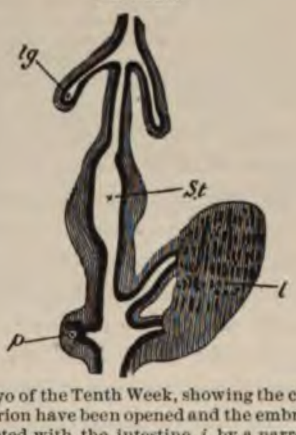


FIG. 127.—(From Allen Thomson.) Sketch of Human Embryo of the Tenth Week, showing the coil of intestine in the umbilical cord. The amnion and chorion have been opened and the embryo pulled aside from them. *v*, umbilical vesicle, connected with the intestine, *i*, by a narrow cord. The smaller figure shows the proximal portion of the umbilical cord more magnified: *i*, intestine; *vi*, vitello-intestinal duct.

FIG. 128.—(From Balfour, after Götte.) Diagram of Part of the Digestive Tract of a Chick Embryo of the Fourth Day. The black line indicates hypoblast: the shaded portion, mesoblast of the splanchnopleure; *lg*, rudiment of lung; *St*, stomach; *l*, liver; *p*, pancreas.

vitelline, and mesenteric veins to the developing liver has been already described (p. 180).

*The Development of the Pancreas* is essentially like that of the liver. It originates a little more posteriorly on the primitive duodenum. Its gland-cells are derived from the hypoblast of the alimentary tube, and the rest of its tissues (except nerve-fibres) from the mesoblast.

*The Lungs* (Fig. 128) are a pair of hollow outgrowths from the fore-gut, lined by hypoblast and covered by mesoblast. The first indication of them is (Fig. 129) a dorso-ventral elongation of the primitive œsophagus; a cross-section at this stage is somewhat hour-glass in form, as represented at 1. The dorsal widening of the hour-glass remains as the gullet; the ventral develops into the trachea and bronchi. The trachea before becoming separated from the fore-gut commences to divide into right and left tubes (*l*, Fig. 129, 3). These tubes ultimately diverge posteriorly and form the bronchi (4, Fig. 129), and by branching give rise to the bronchial tubes (Fig. 130), and the vesicular expansion of the ends of these gives origin to the pulmonary alveoli. From the preceding account of their developmental history it will be obvious that the lungs are outgrowths from the ventral side of the anterior portion of the archenteron. They arise just behind the fifth visceral cleft: their epithelium, like that of the trachea and larynx, is derived from hypoblast, while the rest of the pulmonary, tracheal, and laryngeal tissues are derived from the mesoblast of the splanchnopleure.

FIG. 129.

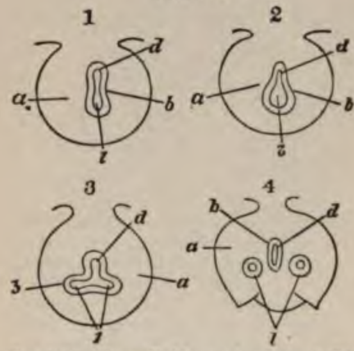


FIG. 130.

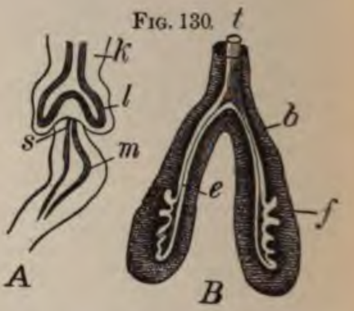


FIG. 129.—(From Balfour, after Götte.) Diagrams illustrating the Origin of the Lungs: *a*, mesoblast of œsophageal portion of splanchnopleure; *b*, hypoblast; *d*, cavity of alimentary canal; *l*, cavity of pulmonary diverticulum. In 1 the fore-gut has begun to divide into dorsal and ventral tubes; the dorsal becomes the pharynx or gullet; the ventral, the larynx and trachea. In 2, the laryngo-tracheal tube has become expanded laterally. In 3, it is shown as subdividing into two tubes communicating with one another and with the alimentary canal. In 4 the subdivision is completed posteriorly, and the cross-section shows the bronchi quite separate from one another and from the fore-gut.

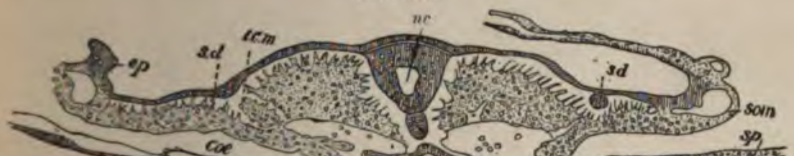
FIG. 130.—(From Landois.) *k*, mesoblast of splanchnopleure; *l*, hypoblast; *m*, stomach; *s*, lower part of œsophagus; *t*, windpipe; *b*, *e*, bronchi; *f*, commencing bronchial tubes and pulmonary air-cells.

The *genital* and *urinary organs* are so intimately associated in much of their developmental history that it will be convenient to describe them together.

In some of the lower vertebrates there develop successively three pairs of excretory organs, known as the *pronephros* or head-kidney, the *mesonephros* or Wolffian body, and the *metanephros* or true kidney. There are good grounds for believing that each of these organs primitively consisted of a number of tubes (the segmental tubes), one for each segment of the body, and that each segmental tube opened by one end into the general body-cavity (pleuroperitoneal cavity), and by another into a special duct leading to the exterior. The duct of the pronephros is a tube recognized in the chick embryo by J. Müller in 1830, and is known by his name. The duct of the mesonephros becomes the Wolffian duct, and that of the metanephros the ureter. In all existing higher vertebrates the development of these parts has become greatly modified from the ancestral method; and perhaps none of the advances in comparative embryology made during the last twenty-five years are more interesting than those which have made plain the origin and hereditary meaning of the genital and urinary ducts.[1]

*The Wolffian duct* is the first to be easily recognized in birds and mammals. A cross-section of the dorsal region of a chick embryo (Fig. 66) shows it as a solid rod of cells, *Wd*, lying in the angle between the mesoblastic somite and the peripheral mesoblast. This rod has until quite recently been supposed to be of mesoblastic origin. But Flemming (Fig. 131), Hensen, Perényi, and others have proved that it arises from the epiblast; which is a fact of fundamental importance. In most annelids (the earthworm, for example) the segmental tubes, opening on their inner end into the cœlome, open also directly on the exterior. In vertebrates (which we have many grounds for believing to have had an annelidan ancestry) the outer ends of the segmental

FIG. 131.



(From Haddon, after Flemming.) Transverse Section of Rabbit Embryo at stage when sixteen somites were present—shading diagrammatic: *al*, alimentary canal, still wide open below; *ce*, cœlome; *ep*, epiblast; *hy*, hypoblast; *icm*, intermediate cell-mass; *nc*, neural canal; *sd*, segmental duct; *som*, somatic mesoblast; *sp*, splanchnic mesoblast.

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[1] For a full bibliography up to 1882, see Allen Thomson in Quain's *Anatomy*; references to important later discoveries may be found in Haddon, *Introduction to the Study of Embryology*.

tubes open not immediately on the surface, but into a general segmental duct (Wolffian duct), which opens into the hinder end of the primitive alimentary canal. To account for this fact has long been a difficulty, but now that the Wolffian duct has been found to be epiblastic in origin, it is easy to conceive that in primitive vertebrates the segmental tubes may have opened into a groove on the exterior, and that this groove may, much as the medullary groove, have closed over and been separated from the external epiblast: in this condition we find it in Fig. 131; and as development proceeds it becomes more and more imbedded in mesoblast.[1] The posterior end of this primary segmental duct opens at first into the hind-gut, and later into the urogenital sinus (p. 194).

As development proceeds the Wolffian duct becomes buried deeper (*wd*, Figs. 79, 81) in the mesoblast. Meanwhile, the pleuroperitoneal cavity expands, and the mesoblast cells which lie on its mesial side multiply rapidly and give rise to a projection which extends into the cœlome, especially in the dorsal region of the embryo. This projection is part of the *intermediate cell-mass*. At this stage segmental tubes begin to burrow-in from the body-cavity and to connect with the Wolffian duct. They are the Wolffian tubules, or the tubules of the mesonephros: subsequently they lose their openings into the pleuroperitoneal cavity, which indeed the posterior tubules never possess.

FIG. 132.

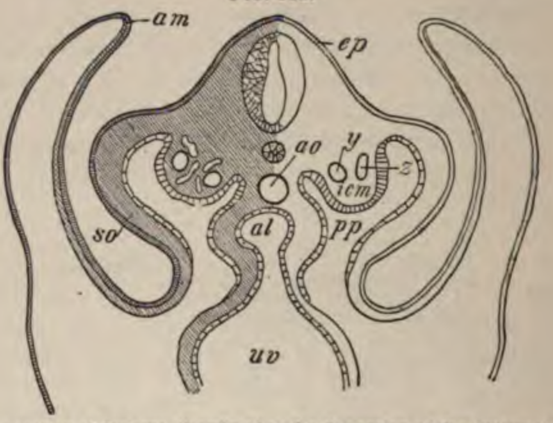

**Diagram of Cross-section of Embryo, shortly after the formation of the intermediate cell-mass.** *icm*: the peritoneal cells on its surface are seen to have become enlarged; *ao*, aorta: *y*, Wolffian duct, now buried deep in the mesoblast; *z*, duct of Müller: on the left side several Wolffian tubules are shown in section; *al*, alimentary canal; *am*, amnion; *pp*, cœlome.

In birds and mammals the pronephros is very imperfectly developed, and lasts only for a very short period. Its duct, however, becomes well marked on each side, and runs back parallel to the Wolffian duct (Fig. 133), to open into the cloaca near the root of the allantois.

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[1] See Haddon: *loc. cit.*, p. 250.

The pronephros has at first several openings into the body-cavity: all of these close but one, which remains in the female as the mouth of the Fallopian tube.

In mammals the ureter is the first-formed part of the permanent kidney. Each ureter arises as a tubular outgrowth from near the posterior end of the corresponding Wolffian duct. Extending forward, it enters the intermediate cell-mass just behind the mesonephros. In this mass it branches and forms the uriniferous tubules and their lining epithelium. Its anterior end, just before the branching commences, dilates to form the pelvis of the ureter. The branching of the uriniferous tubules within the kidneys is a secondary process. There can be little doubt that the ancestral segmental uriniferous tubes were unbranched, and that the same is true of the primitive Wolffian segmental tubes, though these also in the human embryo subdivide and become very numerous.

Fig. 133.

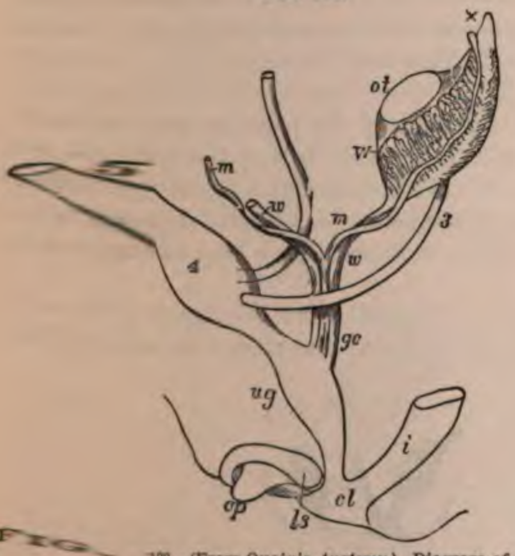


Fig. 134.

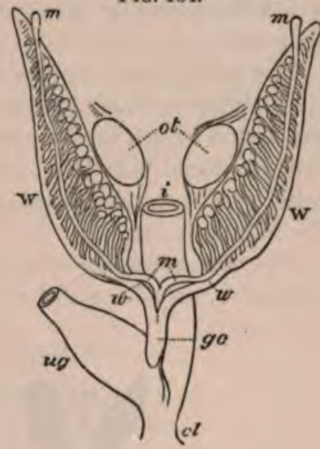


Fig. 133.—(From Quain's *Anatomy*.) Diagram of the Primitive Urogenital Organs of the Human Embryo, before sexual distinction. The posterior parts are drawn chiefly in profile, but the Müllerian and Wolffian ducts are represented as if viewed nearly from the ventral aspect, entire upon the left, but cut short upon the right side of the embryo: 3, ureter; 4, urinary bladder; 5, part of urachus; *ot*, genital ridge from which ovary or testes will develop; W, Wolffian body; ×, its anterior part, from which the coni vasculosi develop: *w*, *w*, Wolffian ducts; *m*, *m*, Müllerian ducts: these become imbedded near the urogenital sinus, together with the Wolffian ducts, in a cord, the *genital cord*; *cl*, cloaca; *ug*, urogenital sinus; *i*, rectum; *cp*, rudiment of penis or clitoris; *ls*, rudiment of labium major or scrotum.

Fig. 134.—(From Allen Thomson.) Diagrammatic Outline of the Wolffian Bodies, and their relation to the ducts of Müller and the reproductive glands: *ot*, seat of origin of ovary or testes; W, Wolffian body; *w*, Wolffian duct; *m*, duct of Müller; *gc*, genital cord; *ug*, urogenital sinus; *i*, rectum; *cl*, cloaca.

The ureters soon lose their connection with the Wolffian ducts, and

(3, Fig. 133) form separate openings for themselves into the developing urinary bladder.

The hind-gut, at first closed behind, is (p. 121 and Fig. 43) opened by an ingrowth (the *proctodæum*) from the exterior, which forms the *cloaca* (permanent in the lowest mammals and in birds and reptiles). Into the cloaca the hind-gut and the Müllerian and Wolffian ducts and the ureters at first open. In man and other higher mammals the primitive cloaca soon commences (Fig. 133) to subdivide into a dorsal portion, which receives the hind-gut, *i*, and a ventral portion, *ug*, the urogenital sinus, which is continuous anteriorly with the commencing urinary bladder, 4, and receives on its dorsal side the *genital cord*, *gc*, in which the posterior portions of the Wolffian and Müllerian ducts are contained.

The human urinary bladder (an expansion of the posterior part of the allantoic stalk, p. 129) appears as a fusiform cavity near the end of the second month of intra-uterine life. The ureters at this period open into its dorsal side (Fig. 133), and the urachus (p. 130) has become solid. "The spindle shape of the bladder is retained for a long time in the human fœtus."

The accompanying diagrams (Figs. 135–138) from Stirling, after Schroeder, may be useful as aiding the reader to understand the subdivision of the primary cloacal chamber, though they refer more especially to the female embryo, and the Wolffian ducts are omitted.

FIG. 135.

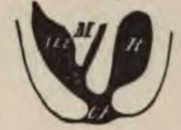


FIG. 136.

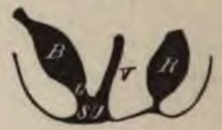


FIG. 137.

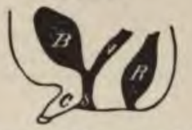


FIG. 138.

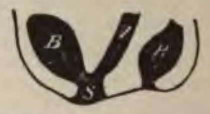


FIG. 135.—CL, cloaca which has opened into primitive hind-gut, and communicates with the rectum and allantois: the posterior portion, ALL, of the latter has commenced to dilate to form the urinary bladder; M, duct of Müller.

FIG. 136.—The cloaca has divided into a ventral portion, SU, the urogenital sinus, which communicates ventrally with the urethra, U, and the bladder, B, and more dorsally with V, the vagina, formed by fusion of the ducts of Müller; R, the rectum.

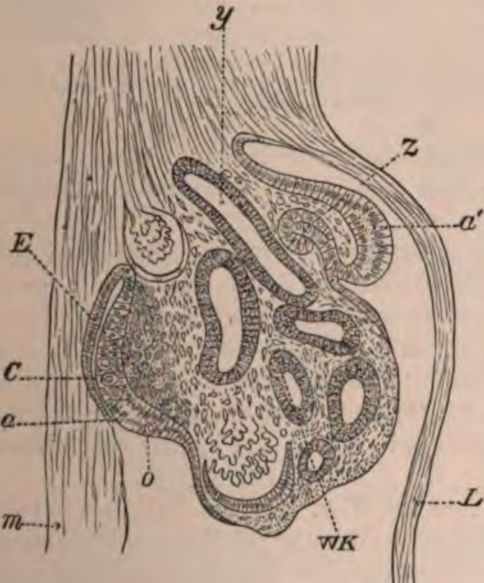
FIG. 137.—The perineum or tissues separating the rectum from the urogenital sinus are well developed; the neck of the bladder has become constricted to form the primitive urethra, and is separated from the vaginal passage, though both open into the common urogenital sinus, S, and the clitoris, C (in the male the rudiment of the penis) has appeared.

FIG. 138.—The urogenital sinus of the female, S, remains as the cleft between the sides of the external aperture of the labia minora: it communicates in front with the bladder, B, and dorsally with the vagina, V.

The development of the genito-urinary organs, so far as described in the preceding pages, is common to both sexes. In later stages the duct of Wolff almost disappears in the female, while in the male it constitutes the vas deferens; the Müllerian ducts, on the contrary, atrophy in the male, but form Fallopian tubes, uterus, and vagina in the female.

*The Essential Sexual Glands* develop in both sexes in close association with the ducts of Wolff and Müller, and in the neighborhood of the mesonephros (*ot*, Fig. 134). The cells lining the abdominal region of the primitive cœlome early become differentiated as its lining epithelium; in most regions they quickly become flat scales, but over the bulging of the intermediate cell-mass (Fig. 132) they enlarge and become columnar in form. These enlarged cells remain for some time over all of the projecting surface of the intermediate cell-mass, and even extend beyond it upon the outer side of the developing mesentery (Fig. 139). They soon become flattened over most of the mass, but remain columnar and multiply for some time on its inner and outer sides: on the latter they give origin to the Müllerian duct and some segmental tubes ($a'$ and $z$, Fig. 139) and soon cease to be distinct; on the

FIG. 139.

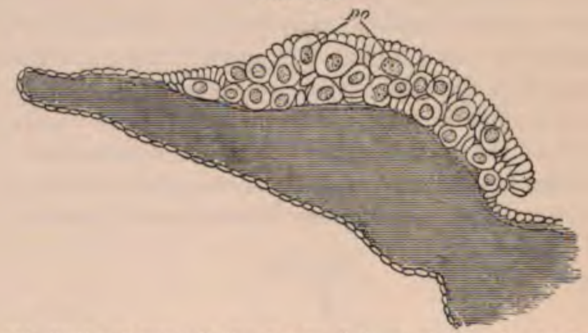


(After Waldeyer.) The Intermediate Cell-mass projecting into the body-cavity, and after the development within it of the Wolffian and Müllerian ducts, and on its mesial side of the germinal epithelium (compare with Fig. 132): *m*, mesentery; L, somatopleure; *z*, duct of Müller, and *a'*, the cells which involute to form its segmental tubes: *a*, germinal epithelium; C, primitive ova within the germinal epithelium; E, commencing stroma of ovary or testis; WK, Wolffian body; *y*, Wolffian duct.

former (C and *o*) they constitute the primitive germinal epithelium. The mesoblast (E, Fig. 139) lying beneath this epithelium gives rise to the blood-vessels and connective tissue (*stroma*) of the ovary or testis, as the case may be. At this stage it is difficult or impossible to detect the sex of the embryo from the structure of the sexual glands.

In the female some cells of the germinal epithelium enlarge (*po*, Fig. 140) to form the primitive ova. Surrounded by other cells from the germinal epithelium, they grow into the ovarian stroma as the egg-tubes (Fig. 3), and give rise to the primitive Graafian follicles (p. 70).

FIG. 140.



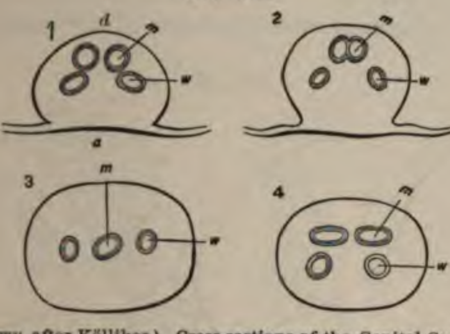
(From Balfour.) Section through Young embryo *Scyllium*, showing the primitive germinal cells, *po*, lying in the germinal epithelium which covers the mesial side of the intermediate cell-mass in the region of the mesonephros.

The testicle is distinguishable from the fœtal ovary about the eighth week. The cells which in the female form ova, in the male subdivide and give origin to the spermatozoa, while the cells which correspond to the lining cells of the female egg-tubes develop the lining cells of the seminiferous tubules. These canals may be detected in the human embryo of ten weeks; they branch, and during the third month are collected into groups, indicating the lobular subdivision of the adult testis.

*The genital cord* (*gc*, Figs. 134 and 141) is a cylindrical mass in which, in both sexes, the ducts of Müller and Wolff become imbedded near the urogenital sinus. The four ducts (two from each side) are at first separate (Fig. 141). The Müllerian ducts (2, 3, Fig. 141) coalesce at their lower ends, and in the female enlarge to form the vagina and the posterior portion of the uterus; in the male the lower fused portions of Müllerian ducts remain as the prostatic vesicle, or *uterus masculinus*.

In the female the more anterior portions of the ducts of Müller form the upper part of the body of the womb and the Fallopian tubes: in the male the anterior parts of the Müllerian ducts disappear almost completely, but even in the adult a remnant is to be found on each side between testis and globus major, as the so-called hydatid of Morgagni.

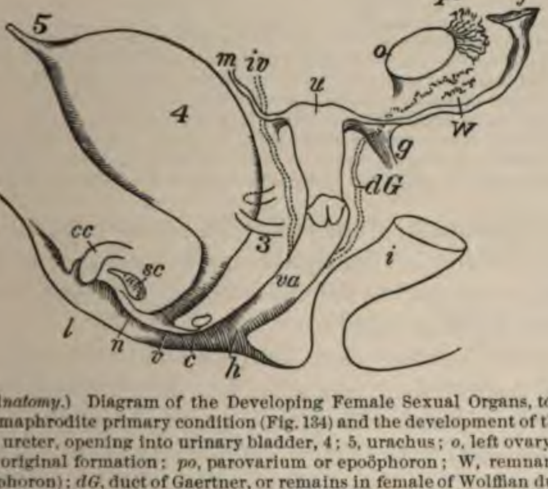
Fig. 141.



(From Quain's *Anatomy*, after Kölliker.) Cross-sections of the Genital Cord of the Embryo of a Female Calf: 1, 2, 3, 4, at different levels, commencing from the front; *a*, ventral, *d*, dorsal aspect; *m*, ducts of Müller; *w*, Wolffian ducts.

The Wolffian ducts become in the male (Fig. 143) the vasa deferentia and ejaculatory ducts: the vesiculæ seminales arise as diverticula from their lower parts. In the female these ducts almost entirely disappear, but traces of them may be found as the canals of Gaertner (Fig. 142).

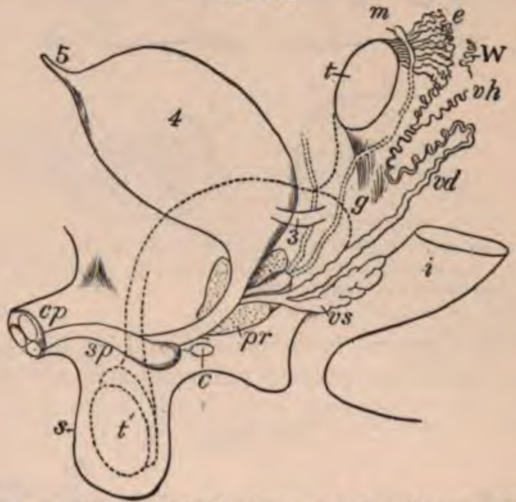
Fig. 142.



(From Quain's *Anatomy*.) Diagram of the Developing Female Sexual Organs, to be compared with the hermaphrodite primary condition (Fig. 134) and the development of the male organs (Fig. 143): 3, ureter, opening into urinary bladder, 4; 5, urachus; *o*, left ovary, nearly in the place of its original formation; *po*, parovarium or epoöphoron; W, remnants of Wolffian ducts (paroöphoron); *dG*, duct of Gaertner, or remains in female of Wolffian duct; *u*, anterior part of body of uterus, still presenting some trace of its primitive formation from the fusion of the paired Müllerian ducts; *f*, peritoneal opening of left Fallopian tube; *m*, right duct of Müller (Fallopian tube) cut short; *g*, round ligament; *i*, rectum; *va*, vagina; *h*, position of hymen; C, Cowper's gland or gland of Bartholin; *cc*, corpus cavernosum clitoridis; *n*, nympha; *l*, external labium; *v*, vulva.

Meanwhile, most of the Wolffian body (mesonephros) disappears on each side, but remnants of it may be found in adult men and women. In the female they constitute the parovarium (epoöphoron or body of Rosenmüller, Fig. 142, W). In the male the ultimate fate of some of the Wolffian tubules is more important: they connect (*e*, Fig. 143)

FIG. 143.



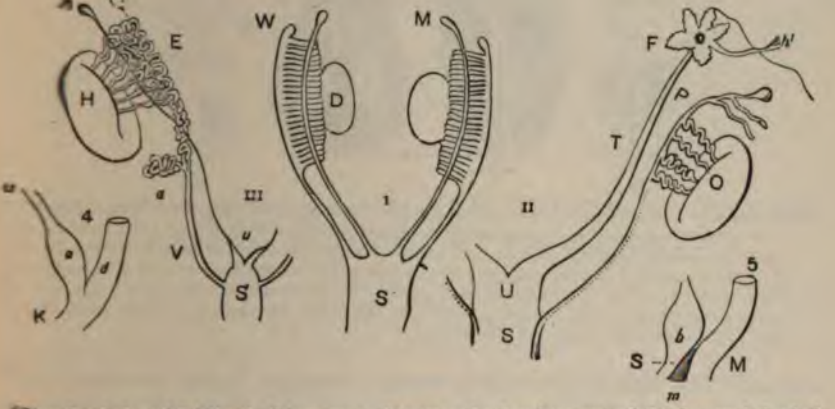
(From Quain's *Anatomy.*) Diagram of the Developing Male Sexual Organs, to be compared with Figs. 134 and 142: 3, ureter; 4, urinary bladder; 5, urachus; *t*, testicle in the place of its origin; *e*, caput epididymis; *vd*, vas deferens; W, remnants of Wolffian tubules, forming the organ of Giraldès or the parepididymis; *vh*, vas aberrans; *m*, duct of Müller, the upper part of which remains as the hydatid of Morgagni: most of its middle portion disappears, but its lower end usually remains as the uterus masculinus; *vs*, vesicula seminalis; *pr*, prostate; C, Cowper's gland; *cp*, corpora cavernosa penis, cut short; *sp*, corpus spongiosum; *s*, scrotum; *t′*, final position of testis: the dotted lines indicate the course of its descent.

the seminiferous tubules of the testis with the epididymis, and form the *coni vasculosi.* Most of the epididymis is formed from the Wolffian duct, which is continued as the vas deferens. The vas aberrans is the relic of some Wolffian tubules.

*Descent of the Testicles.*—Both the ovary and testicle travel back from the place of their original formation, but the former much less in the great majority of cases. The testis enters the internal inguinal ring during the seventh month of intra-uterine life; by the end of the eighth month it has usually reached the scrotum, and before birth the communication between the peritoneal cavity and the tunica vaginalis is normally closed. In rare cases (p. 91) the ovaries take a similar course and enter the labia majora.

*The Development of the External Genitals.*—The formation of the cloaca has already been described (pp. 121 and 194) and figured (Figs. 43 and 133), as also its separation in both sexes (Fig. 134) into an anal and a urogenital portion. The urogenital sinus is at first narrow and deep, but soon becomes shallow (Fig. 136), and meanwhile the perineal tissues separate it more and more from the anus. Before the subdivision of the cloaca a genital eminence (*h*, Fig. 145, I) appears at its ventral or anterior end about the sixth week. On each side of the cloacal slit outgrowths of skin and subcutaneous tissue (*w*, Fig. 145, II) become

FIG. 144.

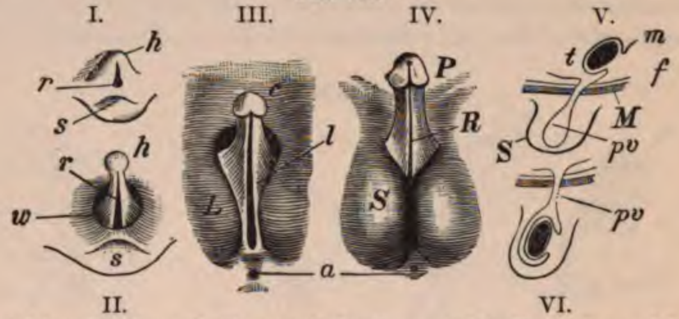


(From Landois and Stirling.) Diagrams to illustrate the Development of the Internal Genital Organs in Both Sexes: I, hermaphrodite or undifferentiated condition: D, ovary or testis, lying upon the tubules of the Wolffian body; W, Wolffian duct; M, duct of Müller; S, urogenital sinus. II, modifications in the female: T, primitive Müllerian duct, forming the Fallopian tube and developing fimbriæ, F, around its peritoneal opening; *h'*, ovarian hydatid; *u*, uterus, forming by fusion of the posterior ends of the ducts of Müller; S, urogenital sinus; O (answering to D in I), ovary; P, parovarium, or remnant of Wolffian body and duct. III, modifications in the male: H, testis, corresponding to D in I; *e*, epididymis; *h*, hydatid of Morgagni; *a*, vas aberrans; V, vas deferens, or Wolffian duct; *u*, uterus masculinus, the remnant of the lower ends of the fused ducts of Müller; S, urogenital sinus.

prominent (see also *ls*, Fig. 133). At the eighth or ninth week there is a groove in the under (posterior) side of the genital eminence, with well-marked side-walls (*r*, Fig. 145) leading back to open into the cloaca. The development of the perineum divides this groove (during the third month) transversely into a smaller anal opening and a larger urogenital. This condition (III, Fig. 145) is but slightly modified in the female. The genital eminence in that sex remains small and constitutes the clitoris (*c*, III, Fig. 145, and *cc*, Fig. 142). The side-walls (*w*, II, Fig. 145) remain separate and form the labia minora (*l*, III, Fig. 145), while the cutaneous folds (*w*, II, Fig. 145) enlarge and become the labia majora (*l*, Fig. 142, and *L*, Fig. 145, III). The urogenital sinus is therefore permanent in woman, and forms the *vestibule*, which has in front of it the clitoris, and, opening into it, the urethra and vagina.

In the male a further development takes place (Fig. 145, IV). The genital eminence enlarges to form the penis, and the groove beneath it closes so as to form the penial urethra. The corpus spongiosum of man is for the most part equivalent morphologically to the nymphæ of the woman, which remain in a separated and more embryonic condition. The skin-folds, which remain separate in the female as the labia majora (*L*, III, Fig. 145), coalesce in the male (IV, *S*) to form the scrotum.

Fig. 145.



(From Landois and Stirling.) To illustrate the Development of the Human External Genitals: I: *h*, genital eminence; *r*, cloacal aperture; *s*, tail or coccyx of embryo. II: *h*, genital eminence; *r*, cloacal opening; *w*, commencement of labia majora or scrotum, according to sex; *s*, embryonic tail. III, next stage, practically permanent in the female: *c*, genital eminence (clitoris); *l*, nymphæ; *L*, labia majora; *a*, anus. IV, later or male condition: *P*, penis; *R*, edges of embryonic folds infolding to enclose the penial urethra; *S*, scrotum; *a*, anus. V and VI, illustrate the descent of the testicle.

# THE FŒTUS: ITS PHYSIOLOGY AND PATHOLOGY.

BY BARTON COOKE HIRST, M. D.,
PHILADELPHIA.

## THE DEVELOPMENT OF THE FŒTUS IN THE DIFFERENT MONTHS OF PREGNANCY.

THE changes in the developing embryo and fœtus[1] that mark its growth from month to month are not only of engrossing interest to the physiologist, but have their practical value for the obstetrician as well when he would determine the probable date of impregnation from the appearance of the cast-off ovum. The importance of such a decision, frequently involving serious medico-legal questions, need only be mentioned to be appreciated. The intelligent explanation of many congenital deformities and intra-uterine accidents and diseases also depends so intimately upon a certain amount of knowledge in regard to the story of intra-uterine development that no further excuse need be offered for occupying space in a practical work with a brief description of some of the more marked changes that occur in the process of transforming a simple cell into the infant at term, with all its future possibilities of thought, speech, and action—the most complex being of animal creation.

*First Month.*—The life-history of the human ovum during the early part of the first month is involved in considerable doubt. The place in which the spermatic particle and ovule meet, the length of time required for the passage of the latter from the ovary to the uterine cavity, the part that the lining membrane of the oviduct and its secretion plays in the nourishment of the ovule and in the production of certain modifications in the external coat, are all matters yet in dispute; and as direct observation of the human ovum during and shortly after impregnation fails us, we must base our theories as to the site in which this phenomenon occurs, as to the changes that immediately succeed it, upon what has been actually seen to occur in the lower animals and upon the clinical history of those pregnancies in which the ovum is developed in an unnatural situation. Thus it is argued that the spermatic particle must penetrate the ovule shortly after its escape from the Graafian follicle, for the occasional occurrence of abdominal and tubal pregnancies proves that the so-called spermatozoa can make their way far into the tube, and even on to the surface of the ovary; and what is seen in animals makes it probable at least either that the outer coating of the ovule, during its passage through the tube, receives an additional thickness from an albuminous deposit upon it, or that the original cell-wall becomes denser and more tough by a process of coagulation; either of which conditions would render the penetration of the ovule by the spermatic particle unlikely if not impossible. On the other hand, it is claimed[1] that if the ovule escapes from the ovary at the beginning of the menstrual flow, and if the fruitful coition occurs only some days after menstruation has ceased, as is common at least among civilized people, the time that intervenes between the rupture of the Graafian follicle and the deposition of semen in the female genital tract has been too great to lend probability to the idea that the ovule still remains in the ovarian extremity of the oviduct, but, on the contrary, would ensure its presence in the uterine cavity. The fact that the cilia of the uterine epithelial cells work upward, while those of the tubes work toward the uterus, is pointed to as corroborative evidence in support of the view that the upper part of the uterine cavity is the meeting-place of spermatic particle and ovule; and it is asserted that the rhythmical contraction of the muscles in the tubal walls which tends to drive the exuded menstrual blood, as well as the ovule, toward the uterus would offer an additional barrier to the ascent of the spermatozoids. This argument is invalidated, however, by the occasional occurrence of extra-uterine pregnancy; and, in spite of the arguments advanced by Wyder and a few others, the prevailing opinion of the present day is that the human ovule becomes fertilized shortly after its expulsion from the ruptured Graafian follicle, most probably in the ampulla of the tube. There has been great difference of opinion in the past as to the manner in which the ovule got from the Graafian follicle, after its rupture, to the orifice of the oviduct, the prevailing idea having been that the fimbriated extremity of the latter became "erected" at the time the ovule escaped, and grasped with its fimbriæ the surface of the ovary, thus displaying a sort of independent intelligence. As, however, the anatomical impossibility of the fimbriæ being closely and accurately applied to the surface of the ovary has been demonstrated,[2] and as the tube contains no true erectile tissue, this theory must fall. The fact that the fimbriæ are provided with ciliated epithelial cells which work actively toward the uterus, and create a stream in the moisture which is always present upon the peritoneal surface, is now held sufficient to account for the transference of the ovule from the ovary to the oviduct. The ovule, being discharged from the Graafian follicle, is either brought directly in contact with the cilia of a fimbria, or else, dropping upon the peritoneum, it is caught in the gentle current of a minute quantity of fluid that always bathes that membrane, and so conveyed to the wide opening of the abdominal end of the oviduct. This explanation will also account for the so-called "external migration" of the ovule, which, discharged from an ovary and failing for some reason to be taken up by the corresponding tube, finds its way to the opposite tube—an occurrence that has been observed in certain cases of tubal pregnancy.[1]

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[1] The usual plan of calling the product of conception "embryo" for the first three months, and afterward "fœtus," is the one adopted here.

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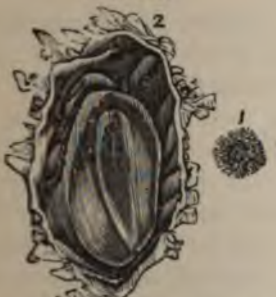
[1] See Wyder: "Beitr. zur Lehre v. d. Extrauterinschwangerschaft u. dem Orte des Zusammentreffens von Ovulum u. Spermatozoen," *Arch. f. Gyn.*, Bd. xxviii. S. 325.

[2] Henle: *Handb. d. Anat. d. Menschen*, 1864, ii. S. 470; and Bischoff: *Entwickelungsgeschichte*, S. 28.

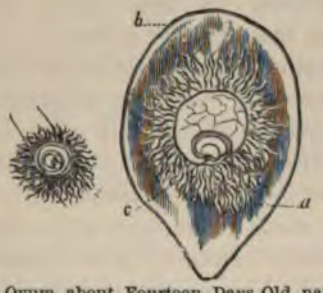
The changes in the ovum immediately before and shortly after impregnation may be passed by.[2] The changes in the uterine mucous membrane preparatory to and after the lodgment of the ovum in one of the depressions formed by the folds into which the hypertrophied mucous membrane is thrown, will be described later. It only remains to notice the successive changes in size and development that would enable one to determine the length of time that had elapsed since impregnation occurred, and to comprehend more fully intra-uterine deformities and diseases.

FIG. 146.



Human Ovum Twelve to Thirteen Days Old (Thomson).

FIG. 147.



An Ovum about Fourteen Days Old, natural size (Hennig): *a*, chorion villi; *b*, blood-clot and decidua reflexa; *c*, embryo.

The youngest human ovum that has been seen was described by Thomson,[3] who estimated its age to be twelve to thirteen days. The embryo in this case was 2 mm. long; the chorion was furnished with thin and simple villi; the allantois was not to be detected; and almost the whole ovum was occupied by the yolk-sac. Other very young human ova have been described by Schroeder van der Kolk,[1] Coste,[2] Hennig,[3] Reichert,[4] Breus,[5] Beigel,[6] Löwe,[7] Kollmann,[8] Ruge,[8] etc. Waldeyer has described a very interesting ovum, just four weeks (twenty-eight to thirty days) old, that measured 19 mm. in length, 16.5 mm. in breadth (about the size of a pigeon's egg), and weighed 2.3 grm. The length of the embryo, in a straight line from cephalic to caudal extremity, was 8 mm., while the actual length of the dorsal line was 20 mm.

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[1] Wyder: *loc. cit.*

[2] See preceding section.

[3] *Edinb. Med. Journ.*, 1839, vol. lii.

FIG. 148.

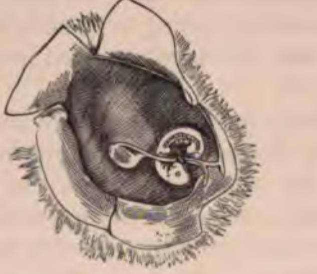

FIG. 149.

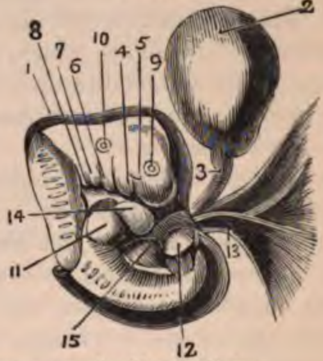

FIG. 148.—Human Embryo *in situ* within its Membranes, 4 weeks old, natural size.

FIG. 149.—Human Embryo in the Fourth Week, magnified: 1, amnion removed in part of the dorsal region; 2, umbilical vesicle; 3, omphalo-mesenteric duct; 4, inferior maxillary tubercle of first pharyngeal arch; 5, superior maxillary tubercle from the same arch; 6, second pharyngeal arch; 7, third; 8, fourth; 9, eye; 10, primitive auditory vesicle; 11, anterior extremity; 12, posterior extremity; 13, umbilical cord; 14, heart; 15, liver.

During the first month the human embryo is indistinguishable from that of other mammals. The ovum at this early period may be described as a double-walled, flattened vesicle filled with fluid. The outer wall bears the branched villi; the inner one is smooth. The connection of the villi with the decidua reflexa, and even with the decidua serotina, is a superficial one, and the ovum is easily separated from its uterine attachments.[9] The yolk-sac, at first occupying nearly the whole ovum, even at the end of the first month is larger than the cephalic extremity of the embryo. The visceral arches are distinct; the limbs are merely rudimentary; the cord is straight, thick, and short; and the amnion is still quite close to the embryo, and is separated from the chorion by a clear space.

As to the embryo itself, during the first month the heart appears as a cylindrical body, which soon becomes S-shaped, and by the fourth week displays four distinct cavities and is covered by its pericardium; it is probably functionally active by the third week;[1] the brain and spinal column are enclosed; the intestinal tract becomes also closed over, but the connection with the umbilical vesicle is still a wide one; the first traces of a liver appear; the primitive kidneys may be seen; and toward the end of this period the eyes may be distinguished at the sides of the head and the rudimentary extremities become visible as four bud-like processes. The oral and anal orifices of the intestinal tract are formed by depressions in the teguments which open into the extremities of the tract after the absorption and disappearance of intervening tissues.

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[1] *Verhandl. d. Ak. d. W. Amsterdam*, iii. 3.

[2] *Histoire du Dêvelop.*, pl. iii.

[3] *Arch. f. Gynäk.*, Bd. v. S. 170.

[4] *Abhandl. d. Königl. Ak. d. W. zu Berlin.*

[5] *Wien. Med. Wochenschr.*, 1877, S. 502.

[6] *Arch. f. Gynäk.*, Bd. xii. S. 421.

[7] *Ibid.*, Bd. xiii. S. 482.

[8] *Ibid.*

[9] See Br. Hicks: *Obst. Tr.*, xiv. p. 149; Langhans: *Archiv f. An. u. Phys.*, 1877, 2 u. 3, 14, S. 231; Ahlfeld: *Arch. f. Gyn.*, Bd. xiii. S. 231.

FIG. 150.

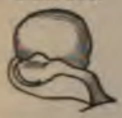


FIG. 151.

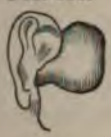


FIG. 152.

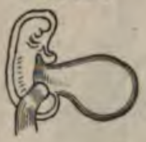


FIG. 153.

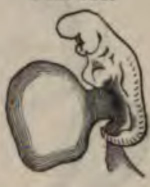


FIG. 154.

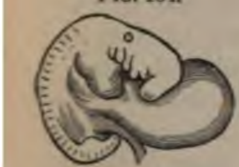


FIG. 155.

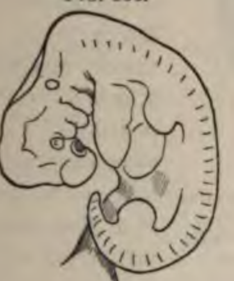
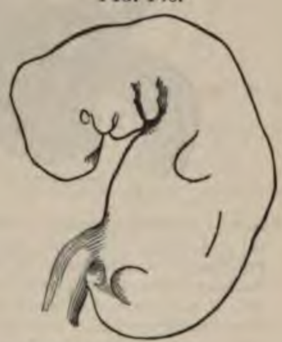


FIG. 156.



Figures showing Stages of Development during the First Month (His).

*Second Month.*—At the beginning of the second month the ovum is the size of a pigeon's egg, and the embryo measures 8 mm. (.3 inch) in a straight line from head to tail. During this month the embryo grows to 2½ cm. in length and the ovum reaches the size of a hen's egg. The visceral clefts close, with the exception of the first, which eventually forms the external auditory meatus, the cavity of the tympanum, and the Eustachian tube. The first visceral arch, dividing into two branches, forms the superior and inferior maxillary processes. The latter, one from each side, approach one another, and finally unite to form the lower jaw. The superior maxillary processes while approaching one another are kept from uniting by the intervention of the frontal process. At the point of junction of this last process with the two superior maxillary processes there occurs occasionally the deformity known as hare-lip, from the failure of the processes to unite, but as union is always perfect before the end of the second month, the arrest of development that results in this deformity must have taken place at some period prior to the third month—a point to which Parvin[1] has particularly called attention. During the second month from the growth of the viscera the body becomes somewhat straightened out, and from the development of the brain the head increases in size. The umbilical vesicle atrophies, and may be found attached to the body by a slender pedicle. The umbilical ring is somewhat contracted, but still contains a few loops of intestine, so that if at this time an arrest in the development of the abdominal walls should occur, a bad umbilical hernia or exomphalus might be the result. The umbilical cord runs straight to the periphery of the ovum. The eyes occupy a position on the side of the head; behind them may be seen the ears, and in front arises the external nose. The limbs are separated into their three divisions, and the first suggestions of hands and feet appear, with the fingers and toes webbed. The Wolffian bodies are much lessened in size, but the kidneys and suprarenal capsules are now developed. The external genitals now make their appearance, but neither internally nor externally is the sex to be distinguished, for the elements of both sexes are present in equal

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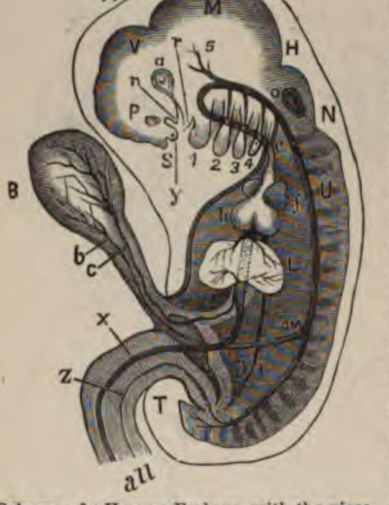
[1] Preyer: *Specielle Physiologie des Embryos.*

FIG. 157.



Scheme of a Human Embryo, with the visceral arches still persistent: *A*, amnion; *V*, fore-brain; *M*, mid-brain; *H*, hind-brain; *N*, after-brain; *U*, primitive vertebræ; *a*, eye; *P*, nasal pits; *S*, frontal process; *y*, internal nasal process; *n*, external nasal process; *r*, superior maxillary process of the first visceral arch; 1, 2, 3, and 4, the four visceral arches, with the visceral clefts between them; *o*, auditory vesicle; *h*, heart, with *e*, primitive aorta, which divides into five aortic branches; *f*, descending aorta; *om*, omphalo-mesenteric artery; *b*, the omphalo-mesenteric arteries on the umbilical vesicle; *c*, omphalo-mesenteric vein; *L*, liver, with arriving and departing veins; *D*, intestine; *i*, inferior cava; *T*, coccyx; *all*, allantois, with *z*, one umbilical artery, and *x*, an umbilical vein.

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[1] Parvin's *Obstetrics*, 1886, p. 136.

degree.[1] Toward the end of the second month or at the beginning of the third the eyelids appear. There are points of ossification to be seen in the lower jaw and clavicle. The villi of the chorion have taken on a more luxurious growth at the point where the future placenta is to be developed, and the fœtus is no longer drawing its nourishment from the umbilical vesicle, but obtains its food from the maternal blood.

FIG. 158.

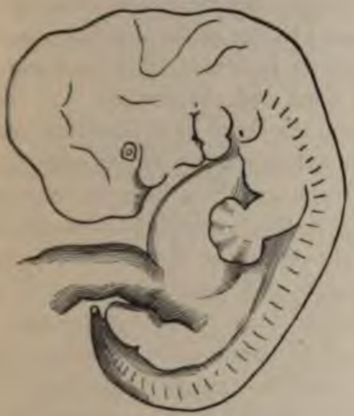
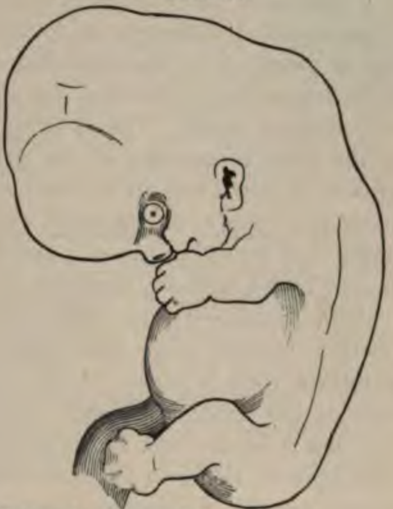


FIG. 159.



Illustrating the Development of the Embryo in the Second Month (His).

*Third Month.*—During this month the ovum reaches the size of a goose's egg (9.5–11 cm. long), and the embryo grows to a length of 7–9 cm. (2.75–3.5 inches) and weighs about 30 gm. (460 grains). The umbilical cord increases in length to 7 cm. (2.7 inches), and becomes twisted. The umbilical ring is smaller, and the intestines are retracted within the abdomen. The fingers and the toes lose their webbed appearance, and the nails appear as fine membranes. The eyes approach nearer to one another and become protected by the lids. Points of ossification may be found in most of the bones, and the neck now separates the head from the trunk. The ribs, developing, divide the trunk plainly into chest and abdomen; the oral and nasal cavities are separated by the palate; the lips close over the mouth and teeth begin to form in the jaws. The sex may be distinguished by the presence or absence of a uterus; cutaneous folds form a scrotum or the labia majora, but the clitoris and penis are still of equal length. The chorion loses its villi, except at the point where the placenta is developing. The latter, though small, can plainly be distinguished.

*Fourth Month.*—In the fourth month the fœtus attains a length of

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[1] See, later on, the description of hermaphrodites.

10–17 cm. (4–6.75 inches) and a weight of 55 gm. (850 grains).[1] The umbilical cord is still more twisted than in the preceding month, and the placenta is increased in size. The head of the fœtus now amounts to a quarter of the whole length of the body, and the cranial bones are in part ossified, although the fontanelles and sutures gape widely. The sex is plainly to be distinguished, the genital fissure, in the case of a male, having united to form the scrotum, leaving in the median line a very distinct raphé. The future prostate is indicated by a thickening at the point of meeting of the genital cord and the urethra. A fine growth of down appears at this time upon the fœtal skin (lanugo), and a few hairs appear on the scalp. The intestines contain meconium; the limbs may be feebly moved; and the fœtus may live, if born, as long as four hours, without, however, making respiratory efforts (Cazeaux).

*Fifth Month.*—During this month the fœtus is about 18–27 cm. (7–10.5 inches) long and weighs about 273 gm. (8 oz.). The umbilical cord is about 31 cm. (12 inches) long. The liquor amnii exceeds the fœtus in weight. The head is relatively very large; the face has a senile look and is wrinkled, and the eyelids begin to open. The skin is richer in fat, is covered with lanugo, and in places with vernix caseosa, a sebaceous material containing also epithelial scales and downy hairs. Some time during the fifth month the mother usually experiences "quickening"—that is, the movements of the fœtus—and the fœtal heart-sounds may be heard on auscultation. If the fœtus should be born at this time, it may make efforts to breathe or cry, but dies in a few minutes or at most hours.

*Sixth Month.*—The fœtus toward the end of the sixth month is 28–34 cm. (11–13.5 inches) long and weighs 676 gm. (23½ oz.). The skin is better supplied with fat, the hairs of the scalp grow longer, eyebrows and eyelashes are distinct. The umbilical cord is now inserted in the middle third between the pubic symphysis and the xiphoid cartilage. The head is still relatively large. The testicles in boys approach the inguinal rings. If a fœtus at this age should be born, it might live from one to fifteen days, but would eventually die from insufficient assimilation of food, from rapid loss of heat, and from imperfect respiration, owing to the undeveloped state of the finer ramifications of the air-passages.

*Seventh Month.*—At the end of this month the fœtus measures in length 35–38 cm. (13.75–15 in.) and weighs 1170 gm. (41¼ oz.). The whole body is covered with lanugo except the palms of the hands and the soles of the feet. The large intestine contains a considerable quantity of meconium. The pupillary membrane, which had hitherto obscured the pupil, now disappears. A child born between the twenty-fourth and twenty-eighth weeks will almost invariably die. The exceptions to this rule have been very rare in the past, but whether in the future, by the aid of incubators and forced feeding (*gavage*), a larger proportion of these very premature children will be saved remains to be seen. An attempt should, at any rate, always be made to preserve an infant, no matter how puny or ill-developed it may be, as long as its respiration suffices to sustain life; for it may be, as Lusk remarks, that the scepticism of physicians in regard to the possibility of saving these premature children is the cause of the unfavorable results that have been obtained in the past.[1]

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[1] Given by Spiegelberg as Hecker's weights and measurements. Spiegelberg: *Lehrbuch*, tr. by Syd. Soc., p. 118.

*Eighth Month.*—The fœtus measures now in length 39–41 cm. (15.25–16 in.) and weighs 1571 gm. (3½ lbs.). The hair on the scalp is more abundant, the down on the face is disappearing. One of the testicles, usually the left, has descended into the scrotum. The nails are firmer, but do not yet project beyond the finger-tips. At the end of the eighth month ossification begins in the lower epiphysis of the femur. The cord is inserted a little below (.6–1.2 in.) the middle point, between the xiphoid appendix and the pubic symphysis. A child born at this period may with proper care survive.

*Ninth Month.*—The length of the fœtus measures 42–44 cm. (16.5–17.25 in.) and the weight is 1942 gm. (4¼ lbs.). There is a decided increase in subcutaneous fat. The nails are not yet perfectly developed. Toward the end of this month, near the thirty-sixth week, the weight will be about 5½ pounds, and the diameters of the skull will be about 1–1.5 cm. less than in a normal fœtus at term.[2] At this period also the bones of the skull are compressible and easily moulded to the shape of the pelvic cavity; and if at this time, about the thirty-sixth week, the infant should be born, with ordinary care it will almost certainly survive. Thus it is that such good results are accomplished in cases of contracted pelves by inducing labor about four weeks before the full time.

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[1] There persists even yet in the minds of some general practitioners, as well as among the laity, as the writer can testify, the idea that children born in the seventh month will be more likely to survive than those born at the eighth month. Prof. Parvin (*Science and Art of Obstetrics*) shows how this superstition has descended, through more than two thousand years, from Hippocrates, who explained that the fœtus is placed with its head uppermost in the uterine cavity until the seventh month, when the increasing weight of the head causes it to fall down to the os uteri. As soon as this occurs the fœtus attempts to make its escape, and if it is strong it succeeds, but if the attempt fails it is repeated at the eighth month, and if the infant now succeeds in escaping from the womb, being exhausted by its previous effort, it is likely to die.

[2] Schroeder, from the measurements of 68 premature infants, gives the average biparietal diameter of the head as 8.83 cm. from the thirty-sixth to the fortieth week; 8.69 cm. from the thirty-second to the thirty-sixth week; 8.16 cm. from the twenty-eighth to the thirty-second week; showing that this diameter, a most important one, is relatively very large even early in fœtal life.

*Tenth Month.*—During the tenth month (thirty-sixth to fortieth week) the fœtus is developing from the condition just described, that is characteristic of the thirty-sixth week, into the infant at term, distinguished by all the features that indicate the arrival of the fœtus at maturity. It is during the last month of pregnancy that the physiology of the fœtus can be studied to the best advantage. It has now reached a large size and requires a considerable quantity of oxygen[1] for its blood and nourishment for its tissues, both of which it obtains from the maternal blood through the medium of the epithelial cells that form the outermost fœtal layer of the placenta. From the fact that the fœtus undoubtedly swallows considerable quantities of liquor amnii during the later months, at least, of pregnancy,[2] and because that liquor contains a small proportion of albumen,[3] some recent writers would have it that the fœtus derives its whole nourishment from the amniotic fluid, while the function of the placenta is confined to the oxygenation of the fœtal blood—a theory that has not yet found general acceptance, nor is it likely that it ever will. Another fact, however, in its favor is the secretion of the stomachic glands, which is going on during the latter period of intra-uterine life.[4] The urine, which is secreted in considerable quantity, and which is, as a rule, albuminous,[5] is voided freely into the amniotic cavity. The fœtus from time to time moves its limbs vigorously, and its heart beats from one hundred and twenty to one hundred and sixty times a minute.[6] It has been claimed that the sex of the child may be foretold by the rapidity of the fœtal heart-sounds, Prof. Wilson[7] of Louisville placing the dividing-line at one hundred and thirty-four—a rapidity greater than that indicating a female fœtus, one below a male. This is only so far correct as boys are, on the average, longer and heavier than girls. The rule may be said to be that the rapidity of the fœtal heart-beat is in inverse ratio to the length and weight of the fœtus.

*The circulation of the fœtal blood* has certain peculiarities that deserve consideration. Beginning at first by a very simple arrangement in a tubular heart and four vessels, two arteries, and two veins, which carry the blood to and from the umbilical vesicle, it soon assumes the characteristics that are most plainly to be seen in the stage of pregnancy under consideration. The blood that has been oxygenated in the terminal villi of the placental tufts is returned by veins of increasing size to the large branches of the umbilical vein that may be seen directly under the amnion on the fœtal surface of the placenta. These branches, converging, unite in the umbilical vein, which is carried by the cord to the fœtal body, which it enters at the umbilicus. Thence it runs along the anterior surface of the abdominal cavity to the under surface of the liver, where, giving off branches to the lobus quadratus, lobus Spigelii, and to the left lobe, it divides into two main trunks at the transverse fissure, the larger of which enters the portal vein, while the other empties into the ascending cava and is called the ductus venosus. Thus by far the greatest quantity of oxygenated blood that is returned to the fœtus from the placenta must first pass through the liver before entering the general circulation. The ascending cava conveys then to the right auricle a large proportion of arterial blood, but mixed with it is the venous blood from the lower extremities and the blood returned from the liver. But this great volume of blood having arrived at the right auricle, instead of descending into the right ventricle, and being carried thence to the lungs, which in their unexpanded condition could not contain it, is guided across the right auricle by the Eustachian valve, and enters the left auricle by means of an opening in the interauricular septum, the foramen ovale. From the left auricle the blood from the ascending cava enters the left ventricle, and is driven thence into the aorta, by which it is conveyed primarily to the upper extremity of the fœtus by the ascending branches of the arch of the aorta. Here

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[1] That the fœtus obtains oxygen from the maternal blood has been proved by (1) cutting off the blood-supply to the uterus, when the fœtus will die of asphyxia (Vesal, Seyl); (2) by the discovery by means of spectral analysis of oxyhæmoglobin in the umbilical vein of the cord (Zweifel).

[2] Zweifel: "Untersuchungen über das Meconium," *Arch. f. Gynäk.*, Bd. vii. 1875, p. 474.

[3] Anderson: *Am. Journ. Obstet.*, Aug., 1884.

[4] "Magensecretion des Fötus," Krukenberg, *Centrbl. f. Gynäk.*, No. 22, 1884.

[5] Ribbert: "Ueber Albuminurie des Neugeboren u. des Fötus," *Virch. Arch.*, Bd. xcviii. S. 527.

[6] The fœtal heart-sounds were first heard by Mayor, a surgeon of Geneva, in 1818, and first accurately described by Legumeau de Kergaradec, 1821.

[7] Parvin's *Obstetrics*, p. 192.

FIG. 160.

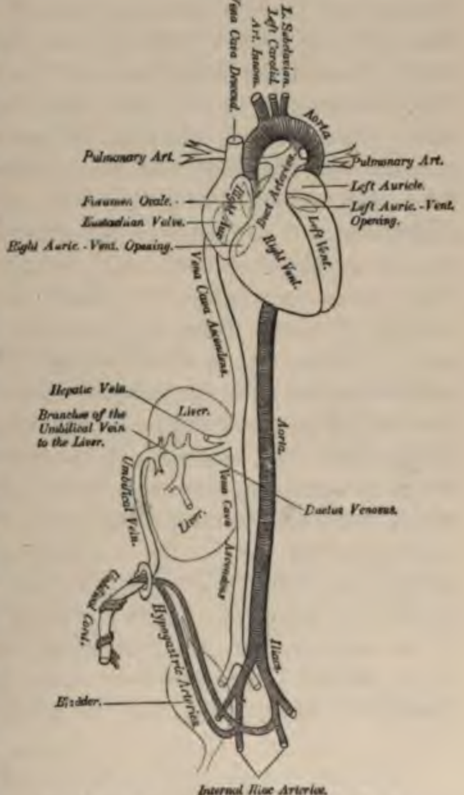

Diagram of the Fœtal Circulation (Flint).

may be seen an arrangement peculiar to fœtal life, by which the blood is diverted from the unused lungs and conveyed instead to the aorta. Just beyond the point at which these branches are given off there opens into the aorta a large branch from the pulmonary artery, the ductus arteriosus, which conveys the blood that enters the right auricle, and then the right ventricle, from the descending vena cava, only a small quantity of blood, sufficient for their nutrition, going to the lungs. Thus it will be seen that the aorta conveys a mixed blood, still further devitalized from the infusion of the venous blood from the head, neck, and upper extremities, to the trunk and lower extremities. It is by this arrangement that a greater quantity of arterial blood is conveyed to the brain, which develops so rapidly during intra-uterine life, and will have such important functions to perform immediately after birth. Following the blood-current down the aorta to the iliac arteries and then to their internal branches, two arteries, one from each branch, may be seen springing upward toward the umbilicus, whence they pass out of the body to form the two arteries of the umbilical cord. Within the body they are known as the hypogastric arteries. The two arteries of the cord carry to the placenta what is usually called venous blood, which in the terminal placental villi discharges into the maternal blood the effete products of the life-processes in the fœtus, and receives in return a fresh supply of oxygen and nutriment, and probably a fair share of the soluble salts of the blood, as well as any other substance, medicinal[1] or otherwise, that the maternal blood may contain in solution or possibly even in suspension. While the passage of matter from the maternal into the fœtal blood seems to occur so frequently, it would appear to be more difficult for substances, aside from the effete products of tissue-activity, to pass from fœtus to mother. There is reason to believe, however, that the poison of syphilis may take this course.[2] It has also been demonstrated that certain drugs, as strychnia, may pass from fœtus to mother.[3] The ease with which medicinal substances will pass from mother to fœtus has given rise to anxiety lest in the administration of powerful drugs to the mother the fœtus might be injuriously affected.[4] It is possible, of course, to harm the fœtus by administering poisonous substances to the mother, but it is extremely unlikely that the fœtus will be much affected unless the dose to the mother much exceeds the usual therapeutic limit. But, like the adult, the fœtus may become accustomed to a drug, and be able finally to endure large quantities of it in the maternal blood.[1]

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[1] Chloroform, carbonic oxide gas, salicylate of sodium, benzoate of sodium, atropia, strychnia, morphia, quinia, corrosive sublimate, iodide of potassium, ether, urea, the bile-salts, soluble salts of lead, tobacco, sulphindigolate of soda, the germs of many diseases, have all been known to pass from mother to fœtus.

[2] See p. 165 for the infection of the mother by syphilis in the fœtus.

[3] Schroeder: *Geburtshülfe*, 8th ed., p. 63.

[4] Parvin's *Obstetrics*, 148

*The temperature of the fœtus in utero* is slightly higher than that of its mother. Priestley,[2] in experiments on rabbits and cats, found the temperature of the fœtus about one degree (Fahr.) higher than that of its mother; which seems natural enough if one considers the very great functional activity in the organs of the rapidly-growing fœtus, and the fact that the liquor amnii, although abstracting heat to some extent from the fœtal body, remains itself at a constant temperature equal at least to that of the maternal body. That the human fœtus also possesses a temperature higher than the maternal body-heat has been proven by taking the temperature *in ano* of a fœtus coming down during labor by the breech, and comparing it with the temperature of the vagina,[3] or by taking the temperature of infants immediately after birth.[4] In these cases the fœtal body is found warmer by 0.5° (C.) than the maternal body.

Of all the organs in the fœtal body, the *liver* seems the most active. How almost all the arterial blood from the placenta goes first to the liver has been noticed. The great quantity of meconium in the fœtal intestines—a substance composed mainly of bile-salts—attests the active secretory work of this organ, and to it too may be attributed the source of the large quantity of glycogen[5] found in fœtal tissues, especially the muscles, where this substance has work to perform the nature of which is not yet understood.

## THE MATURE FŒTUS.

There is no single sign, perhaps, that would enable one to declare a given fœtus to be fully mature, but the weight, measurements, and stage of development, taken together, will indicate with tolerable accuracy the length of time that the fœtus has remained in utero. By the two hundred and eightieth day a healthy fœtus should weigh about

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[1] I was obliged not long ago to administer large doses of morphia daily for a period of some weeks to a patient who was suffering from general septicæmia in the seventh month of pregnancy. The fœtus continued to move actively in utero, and I could detect no change in the fœtal heart-sounds. The woman finally gave birth to a living infant.

[2] "Lumleian Lectures on the Pathology of Intra-uterine Death," rep. for *Brit. Med. Journ.*, 1887, p. 16.

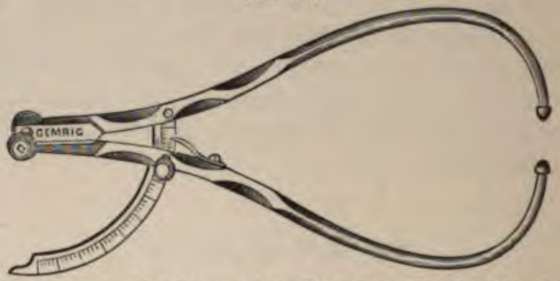
[3] Wurster: *Berl. klin. Wochenschr.*, 1869, No. 37, and *Beitr. z. Tocothermometrie, D. i.*, Zürich, 1870.

[4] See Baerensprung, *Müller's Arch.*, 1851; Schäfer, *D. i. Greifswald;* Andral, *Gaz. hebd.*, July, 1870; Schroeder, *Virch. Archiv*, Bd. xxxv. S. 261; and the *Lehrbuch*, 8th ed., 1884, p. 65, also, Alexeeff, *Arch. f. Gynäk.*, Bd. x. S. 141.

[5] Marchand: "Ueber das Glykogen in einigen fötalen Geweben," *Virch. Arch.*, Bd. c. S. 42.

7⅓–7⅔ lbs., according to the statistics of Lusk and Parvin; but in Europe the weight of the mature fœtus would seem to be somewhat less, for the statistics of Scanzoni, Ingerslev, Hecker, Fesser, and Bailly, including a very large number of observations, give a weight of less than seven pounds. Variations in weight at term between six and nine pounds[1] are by no means rare, and the range of possibility as to the weight of a mature fœtus is a very wide one. Thus Harris[2] tells of one infant that weighed but a pound, and of another, the child of the Nova Scotia Giantess, that weighed twenty-eight and three-fourths pounds. A decided departure, however, from the normal average would indicate, on the one hand, prematurity or a weak development; on the other, the prolongation of pregnancy, race peculiarities, the vigor or excessive size of the parents, especially the mother, or the preoccurrence of several pregnancies. Sex also influences the size of the infant, males being, on an average, larger than females. The length of a mature fœtus is 20–21 inches (51–53 cm.). The width across the shoulders (binacromial diameter) is about 12 cm. (4.75 in.); the dorso-sternal diameter is 9–9.5 cm. (3.5 in.); the biniliac, 9.5–10 cm. (4 in.). The length of the foot is about 8 cm.[3] The dimensions of the head are important, not only as a sign of the development of the fœtus, but from their important relation to the calibre of the parturient canal. The shape and the size of the fœtal head in utero immediately before labor begins, and before the occurrence of the moulding to the irregularities of outline that characterize the pelvic straits and cavity, may be learned from the observation of those infants that have been extracted after Cæsarean section.

FIG. 161.



A Convenient Instrument for Measuring the Diameters of the Fœtal Head (Martin's Pelvimeter).

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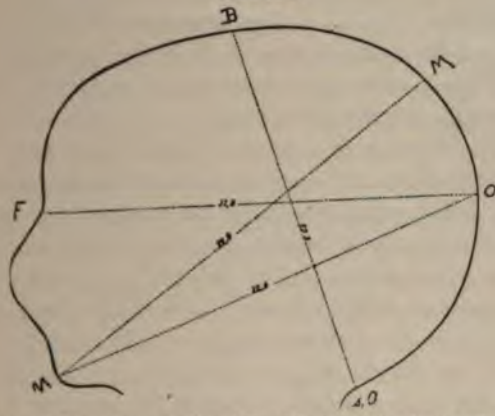
[1] An infant of over nine pounds is not common, while heavier weights are progressively rarer. Out of 1000 infants, Dr. Parvin saw but one that weighed 11 pounds (Parvin's *Obstet.*, p. 138). Of 1156 infants born in the Maternity Hospital, the heaviest weighed 12 pounds.

[2] Note to Playfair's *Midwifery*.

[3] Negri says (*Ann. di. Ostet.*, May–June, 1885) that when the foot measures 8 cm. the fœtus is well developed and weighs about 3500 gms.

FIG. 162.



Shape and Diameters of a Fœtal Head before Labor begins (Budin).

The following dimensions of the fœtal head may be considered characteristic of the normally-developed infant directly after its expulsion from the uterus:

Bitemporal (B. T.) diameter, 8 cm.
Biparietal (B. P.) diameter, 9¼ cm.
Occipito-frontal (O. F.) diameter, 11¾ cm.
Occipito-mental (O. M.) diameter, 13 cm.
Maximum (M. M.) diameter, 13½ cm.
Suboccipito-bregmatic (S. O. B.) diameter, 9½ cm.
Trachelo-bregmatic (T. B.) diameter, 9½–10 cm.
Circumferences: O. F., 34½ cm.; S. O. B., 30; O. M., 37.

These dimensions are subject, however, to considerable modifications. Any of the causes that tend to increase the size of the infant as a whole will likewise influence the size of the head; but even with a normal body-weight and length the head may be so disproportionately large, without being diseased, as to present a most serious complication of labor.[1]

Another valuable sign of maturity in the fœtus is the appearance and extent of certain centres of ossification.[2] In the centre of the lower epiphysis of the femur may be found at birth a spot of ossification measuring 5 mm. in diameter, while a similar but smaller spot is just appearing in the upper epiphysis of the tibia. The centre of ossification in the astragalus is to be found without difficulty, for it first appears at the seventh month of intra-uterine life. The centre of ossification in the cuboid bone is at birth beginning to make its appearance. The ossified spot in the upper epiphysis of the humerus only appears some months after birth.

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[1] Two exceedingly difficult forceps deliveries that recently occurred in the writer's practice were due to this cause. The head measurements were, in one case, B. T., 8½; B. P., 9½; O. F., 13; O. M., 14; S. O. B., 9½. Circumferences: O. F., 38½; O. M., 41¼. In the other, B. T., 8¾; B. P., 10; O. F., 13; O. M., 15½; S. O. B., 9¾. Circumferences: O. F., 38; O. M., 43. The body-weight of the first child was 7½ lbs., that of the second, 8½ lbs.

[2] See Rossié: *Am. Journ. of Obstet.*, 1886, p. 18.

The general appearance of a newborn infant is of value as indicating whether or not the fœtus had reached maturity before its expulsion from the uterus. A healthy infant at term looks stout and well-nourished, owing to a liberal supply of subcutaneous fat. The face is plump and is free from lanugo; miliaria are to be seen about the tip of the nose, but are not nearly so evident as they were in the tenth, and especially the ninth, month of intra-uterine existence (Küstner). The eyes are usually opened, the limbs move vigorously, and the child will seize with its lips the nipple when presented to it, and will suck with energy. The vernix caseosa is abundant only on the back of the child and on the flexor surface of the limbs. The nails project beyond the finger-tips; the cartilage of the ears and nose feels firm; eyebrows and eyelashes are well developed; the hairs of the scalp are about an inch long; the bones of the head are hard and lie close together. The breasts in both sexes are large, and usually a thin fluid can be squeezed out of them. In boys the testicles are usually to be felt in the scrotum, although the tunica vaginalis is not yet closed. In girls the labia majora are usually approximated, although occasionally the minora project between.

THE DETERMINATION OF SEX.—In all countries the number of male children born exceeds the number of females, the average proportion being 106–100; but, as more boys die than girls, by the time puberty is reached the sexes are about equal in number. This normal proportion is, however, in modern times much disturbed by the migratory tendencies affecting chiefly the male populations of old and long-settled countries. The law that governs the production of sex has long been a subject of discussion and speculation. The Hippocratic doctrine that the right ovary produced boys, and the left girls, was for centuries accepted by the majority as the truth, and upon this belief was founded the precept that women who desired male offspring should lie during coition upon the right side, while those who wished daughters must lie upon the left side. By experiments upon animals, by the observation of women in whom one ovary was destroyed by disease, and by a more complete knowledge of the mechanism of impregnation, the long-accepted teaching of Hippocrates was disproved, although not until comparatively recent times. At present it is yet undecided whether the question of sex is decided before impregnation occurs—that is, whether certain spermatic particles or ovules are predestined to produce males, while others will produce females; whether the sex is impressed upon the ovule at the moment of conception; or whether the embryo is possessed of the elements of both sexes until one or the other acquires a preponderating influence owing to causes which may be operative during the early part of pregnancy. The first theory receives its chief support from the fact that unioval twins are invariably of the same sex, which looks as though the ovule was predestined in the ovary to the formation of one or the other sex. The last theory is based upon the study of plants and lower animals, in which the sex is only determined at some time after conception by the influence of nourishment; over-feeding being found to produce females, under-feeding to produce males. It is even possible in the case of certain animals to alter the sex, or at least to produce hermaphrodites, even after the sexual organs have begun to be differentiated.[1] This theory is further strengthened by the fact that in the human embryo the elements of both sexes are always present apparently in equal force during the early part of embryonal life. The belief that the sex of a human embryo is impressed upon it at the moment of conception rests upon the fact that in certain conditions of nourishment or sexual vigor in one or the other parent one sex will preponderate, while under opposite circumstances the other sex will most frequently be produced.[2]

Disregarding the time at which sex is determined, the most diverse conditions have been called upon to explain apparent departures from the normal numerical relation of the sexes at birth. Illegitimacy,[3] age of the parents,[4] conception at certain periods after menstruation,[5] deformities in the female pelvis,[6] the state of nourishment or sexual vigor of the parents,[7] the tendency of each sex to produce the opposite or the reverse,[8] the tendency to produce that sex which is most needed to perpetuate the species,[1] the season of the year,[2] climate and altitude,[3] and the degeneration of a race, as during the degeneration of imperial Rome,[4]—have all been advanced as reasons for apparent excess in the number of male or female births as the case might have been. All these theories, however, have been found either false or inadequate upon further investigation. The only explanation that appeals strongly to the writer's reason is that the individual stronger in mental, physical, and sexual attributes will impress upon the ovule at the moment of impregnation that individual's sex. Personal observation has tended to confirm this view, most markedly in three instances: A gentleman having arrived at middle age, a widower, remarried, his wife being a young and vigorous woman. The children resulting from this union were four in number, all girls. In another case a young man of weakly constitution, threatened with phthisis, married a young woman the perfect type of vigorous womanhood; they had three children, all girls. Again, a gentleman now of mature years, but possessing even yet the most extraordinary mental and physical power, married when young: his children, some five or six in number, were all boys. A perfectly satisfactory explanation of the determination of sex, however, will be difficult to obtain, while the production of the sexes at will must always be an impossibility.

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[1] In the case of the larvæ of bees from impregnated eggs, when the female genital organs have begun to appear, if the nourishment is very insufficient, instead of becoming female workers these animals will actually develop into true hermaphrodites, with the organs of both sexes (Fürst).

[2] Thury (*Zeitschr. f. w. Zoologie*, 1863, Bd. xiii. S. 541) found in twenty-nine experiments upon cattle that in every case, if connection occurred at the beginning of heat, females were produced; if at the end, males.

[3] Fürst (*Arch. f. Gyn.*, Bd. xxviii. S. 19) says that in illegitimate births the males fall below the average (based upon 807,332 cases). This coincides with the experience in the Maternity Hospital in more than 1000 cases.

[4] See Hofacker: *Ueber die Eigensch. welche sich von den Eltern auf die Nachk. vererben*, 1828; Sadler, *Law of Population*, London, 1830; Hecker, *Arch. f. Gyn.*, Bd. vii. S. 448; Bidder, *Zeitschr. f. Geburtsh.*, Bd. ii. S. 358; Ahlfeld, *Arch. f. Gyn.*, Bd. ix. S. 448; Wall, "The Causation of Sex," *London Lancet*, 1887, i., pp. 261. 307.

[5] Thury, *loc. cit.*; Coste, *Comptes rendus*, 1865; Schroeder, *Lehrbuch*, 8te Aufl., 1884, S. 33; Fürst, "Knaben Ueberschuss nach Conception zur Zeit der postmenstruellen Anämie," *Arch. f. Gyn.*, Bd. xxviii. S. 18.

[6] Olshausen: *Klinische Beiträge*, Halle. 1884; Linden, "Hat das enge Becken einen Einfluss auf die Entstehung des Geschlechts?" *Dis. Inaug.*, Marburg, 1884; R. Dohrn, *Zeitsch. f. Geburtsh. u. Gyn.*, Bd. xiv. S. 80.

[7] See Fürst, *loc. cit.*, and Schroeder, *op. cit.*, S. 33.

[8] See Fürst, *loc. cit.*

MULTIPLE FŒTATION.—It is the rule that but one fœtus at a time is developed within the uterus of a human female. Once in 89 pregnancies,[5] however, two fœtuses will be developed simultaneously in the same uterus, so that twins are not of uncommon occurrence. Triplets will be found once out of 7900, quadruplets once out of 371,126 births. Quintuplets are extremely rare. Multiple fœtation may be the result (1) of the impregnation of a single ovum that contains two or more germinal vesicles, or in which the formative material of the area germinativa divides;[6] (2) of the impregnation of two or more ova which were contained either in one Graafian follicle or in separate follicles, the latter being situated either in one or both ovaries.

If the multiple fœtation is the result of the impregnation of a single ovum, there will be but one chorion and one decidua reflexa, although each fœtus will be enclosed in its own amnion.[7] In these cases the sex

[1] Düsing: *Die Regulirung des Geschlechtsverhältnisses bei der Vermehrung der Menschen, Thiere, u. Pflanzen*, Jena, 1884.

[2] According to Düsing (*loc. cit.*), women impregnated in summer give birth to fewer boys than those impregnated in winter (conclusions based on more than ten and a half million births).

[3] Ploss found in Saxony that up to 2000 feet the greater the altitude the larger was the number of male births (at 2000 ft., 107.8–100).

[4] Darwin's *Collected Works.*

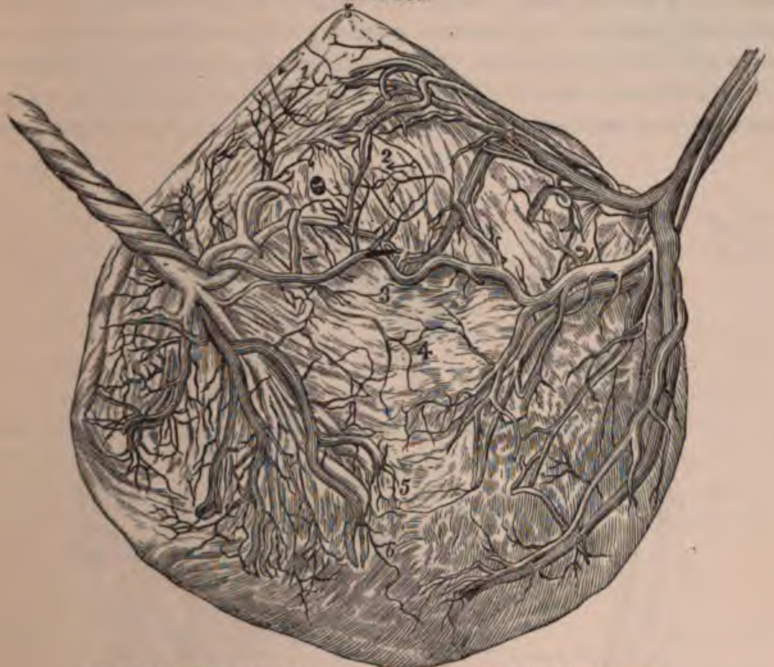
[5] Conclusion of Veit, based on more than thirteen million births.

[6] Ahlfeld: *Arch. f. Gyn.*, Bd. ix. S. 196.

[7] Occasionally two fœtuses are found in a single amniotic cavity, which is to be

of the fœtuses will be the same. The placentæ will usually be found intimately united when expelled at term, presenting extensive arterial and venous anastomoses—a condition that may give rise to the deformity of one of the twins known as acardia (see p. 300, this section). But in the early stages of development each placenta, even in unioval twins, is separate. When the embryos are derived each from a separate ovum, there should be separate deciduæ reflexæ, chorions, and placentæ. Occasionally, however, when the ova are implanted close together, the placentæ may join one another, there may be but one decidua reflexa, and it may be difficult to detect the double layer of chorion that should separate the two ova.

FIG. 163.



Twin Placenta, showing extensive anastomosis of the blood-vessels.

Although twins are not infrequently born, the condition should be regarded as pathological in its influence, at least, upon the fœtus. From statistics collected by Schatz,[1] it appears that in twins from different ova one would be born dead in every 23 cases, while from the same ovum the death-rate would be 1 : 6. One fœtus will perhaps

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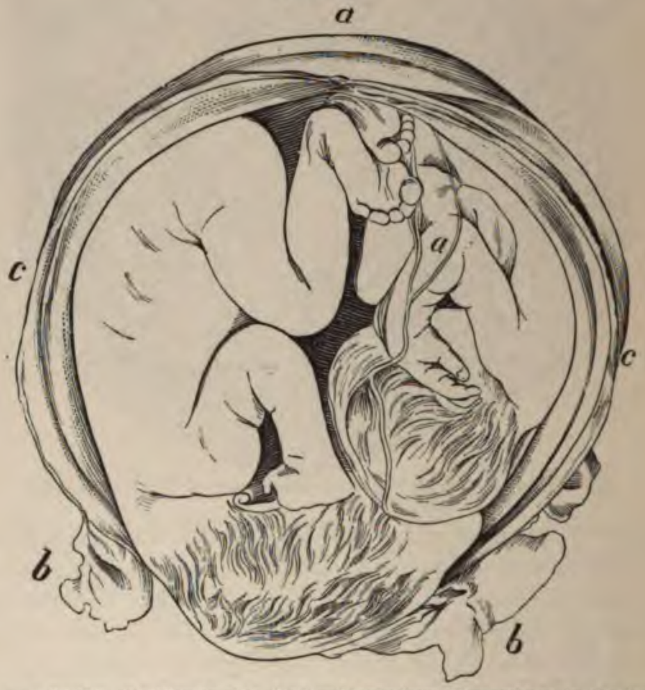
explained (1) by the atrophy and absorption of the contiguous amniotic walls; (2) by rupture of the amnion in the later months from the vigorous movements of the fœtus; or (3) by the development of but a single amnion from the very beginning (Myschkin, *Virch. Arch.*, cviii. S. 133, 146).

[1] *Arch. f. Gyn.*, Bd. xxix. S. 438.

outstrip its fellow in growth, and divert the greater part of the nourishment from the mother to itself, thus growing rapidly and encroaching so upon the room that should belong to the weaker fœtus that the latter is killed, and finally pressed flat against the uterine wall (fœtus papyraceus). Hydramnion is also very common in twin pregnancies, and occasionally one fœtus is converted into an acardiac monster. If the fœtuses of a twin pregnancy escape the dangers of intra-uterine life, there are many perilous complications awaiting them in labor. Should one fœtus die during pregnancy, it is usually retained until term, when the living and dead children are cast off together, widely differing in appearance and development;[1] or else one ovum may be aborted at an early period of pregnancy, while the other goes on developing till term.[2]

FIG. 164.



Twins seen on Section of a Woman who died suddenly from Hemorrhage in the last week o Pregnancy (Sippel): *a*, tear in chorion; *bb*, bladder and vaginal vault; *cc*, uterine walls folded back; *d*, fundus uteri.

Even though both children have been retained in utero an equal length of time, there is usually a marked difference in their length and weight, especially if they have resided in one ovum.[1] In cases of uterus duplex, fœtuses of different ages have been found developing in the two divisions of the uterus. Fordyce Barker reports a case of delivery of two mature children from a woman with a double uterus, one male, the other female, at an interval of two months.[2] Upon such cases, and also upon the fact that of twins in negresses rarely one is light and the other dark, showing of course different paternity, has been based the theory of superfœtation; but as there is no clear proof as yet of the occurrence of ovulation during pregnancy, the possibility of the impregnation of ovules which escaped from their Graafian follicles at rather wide intervals of time, say weeks or months, must still remain in doubt.[3]

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[1] Schultze: *Volkm. Samml. klin. Vorträge*, No. 34.

[2] Sirois: *L' Union médicale du Canada*, July, 1887; and Warren: *Am. Journ. Obstet.*, 1887.

## THE DEVELOPMENT, THE ANOMALIES, AND THE DISEASES OF THE FŒTAL APPENDAGES.

The fœtal appendages play such an important part in the healthy development of the fœtus itself, and their diseases can so seriously affect the growth and the life of the fœtus, that the study of their development, anomalies, and diseases is necessary to a clear understanding of fœtal pathology. First will be considered the development and diseases of the fœtal appendages springing directly from the embryo—namely, the amnion, the chorion, the allantois, and the placenta; lastly, the deciduæ, the maternal envelope of the fœtus.

### THE AMNION.

It has been seen that, after segmentation has occurred, and after the interior of the ovum has become reduced to a granular mass, around which is a membrane composed of a single layer of cells, at a certain point in this membrane there appears a thickening, a heaping-up of the cells. Finally, this small mass of cells resolves itself into two layers (epi- and hypoblast), and between these two appears another layer of cells (mesoblast).

The outer layer, the epiblast, sends a prolongation around the whole interior surface of the ovum, and this receives a reinforcement from the middle layer of cells, or the mesoblast. As now the embryo begins to assume a definite shape and the lateral walls begin to fold in toward one another, and the caudal extremity approaches a little to the cephalic end of the embryo, giving it the arched back so characteristic of the very young embryo, the outer layer of cells, forming a membrane continuous with the outer covering of the embryo, instead of simply being carried forward to meet in the median line in front, sends reduplications backward over the dorsal aspect of the embryo which shortly meet and join one another. Thus there are two cavities formed—one within the membrane thus doubled back upon itself, the other between the inner (the true amnion) of the two layers of membrane and the outer covering of the embryo. The latter is the true amniotic cavity, which is gradually more and more distended by the accumulation of fluid until the membrane which contains it is pushed out on all sides, uniting in front around the umbilical cord, and coming in contact throughout the whole extent of the ovum with the outer membrane (true chorion) already described, to which it becomes loosely united by a gelatinous substance, the tunica media of Bischoff.

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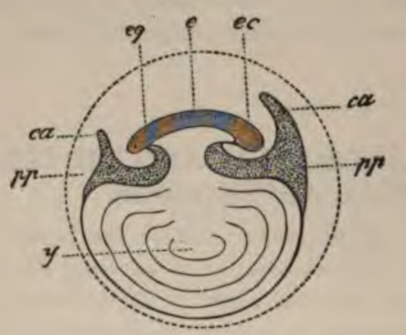
[1] Schatz: *loc. cit.*

[2] See Lusk: *op. cit.*, p. 233, ed. 1886.

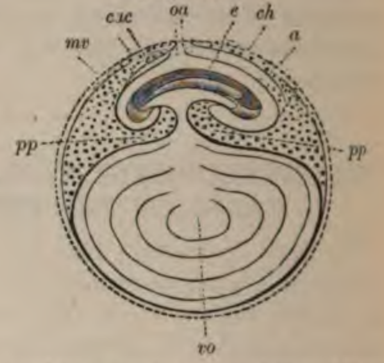
[3] For some interesting observations which would seem to indicate the possibility, at least, of ovulation during pregnancy, see "Ovulation during Pregnancy," Christopher, *Am. Journ. Obstet.*, 1886, p. 457.

FIG. 165.



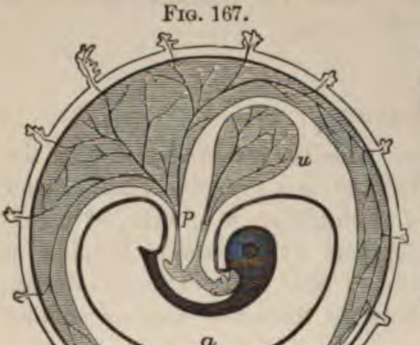
*e*, embryo; *ec*, cephalic extremity; *eg*, caudal extremity; *ca*, amniotic hood; *pp*, pleuro-peritoneal cavity; *y*, umbilical vesicle.

FIG. 166.



*e*, embryo; *a*, amnion; *oa*, amniotic umbilicus; *cac*, amnio-chorional cavity; *pp*, pleuroperitoneal cavity; *ch*, chorion; *mv*, vitelline membrane; *vo*, umbilical vesicle.

FIG. 167.



Completion of the Amnion: *u*, umbilical vesicle; *p*, pedicle of the allantois; *a*, amniotic cavity.

*The Fully-developed Amnion.*—The amnion forms the innermost of the membranes that surround the fœtus at term. It is continuous with the fœtal epidermis at the umbilicus, and forms a complete sheath for the umbilical cord, and also covers the fœtal face of the placenta. In its structure it consists of a single layer of flat endothelial cells turned toward the cavity of the amnion, and externally of a layer of young connective tissue, in which may be seen long spindle- or star-shaped cells with long nuclei imbedded in a fibrous substance (Schroeder). The regular disposition of the inner layer of endothelial cells, however, is disturbed at certain points of the amnion lying over the placenta, where there may be seen numbers of cells heaped together, forming a little villus-like projection. There are, normally, no blood-vessels in the amnion, at least in its later stages of development; their possible occurrence, however, will be referred to later.

THE LIQUOR AMNII.—It is the physiological function of the amniotic membrane to furnish a fluid medium, the liquor amnii, which distends the uterine walls and allows the fœtus some freedom of movement, and by its density, approaching the specific gravity of the fœtus, robs these movements of much muscular effort. It acts as an additional protection to the fœtus from external violence, pressure, and changes of temperature; it receives the urine secreted in the latter part of fœtal life; and perhaps has some little part in the nourishment of the fœtus, or at least in supplying the fœtal tissues with that excess of water which they have been shown to possess during intra-uterine life.[1] That the fœtus actually swallows considerable quantities of liquor amnii admits of no doubt, for not only have lanugo and epidermis-scales been found in the meconium,[2] but also particles of colored matter which had entered the amniotic fluid from the maternal structures (Zuntz). It is not likely, however, that the liquor amnii plays an important part in the nourishment of the fœtus, as claimed by v. Ott and others; for if it did the birth of well-nourished children with a breach of continuity in the upper part of the alimentary tract from the mouth to the small intestines would be inexplicable.

*The Composition of the Liquor Amnii.*—The amniotic fluid is usually clear, occasionally, however, opaque, whitish, greenish, or a dark brown from the presence of meconium, or of a reddish color when the fœtus is macerated. The specific gravity varies in the most remarkable manner—from 1002–1028 (Schroeder), being usually, however, about 1007–1011. Its reaction is weakly alkaline. It contains salts, urea, carbonate of ammonia, kreatinin, albumen, and, besides lanugo, sebaceous matter, epidermis, scales from the fœtal skin, and epithelium from the bladder and kidneys. The *quantity* of the liquor amnii differs at different periods of pregnancy: in the early stages it develops with great rapidity, and at the middle of pregnancy has reached its maximum of about 1–1.5 kilograms (Landois). From this time it diminishes in amount, until at the end of pregnancy its average quantity is 680 grams.[3]

*The Origin of the Liquor Amnii.*—The origin of the liquor amnii has been attributed to a maternal source, or it has been said to be derived entirely from the fœtus, or, again, it is claimed that both the mother and fœtus contribute to its formation. The last view is doubtless correct. The maternal origin[1] of the amniotic fluid has been demonstrated by Zuntz, who injected sodium sulphindigolate into the veins of pregnant rabbits, and found a blue coloration of the amniotic fluid, although there was no coloring matter in the kidneys of the fœtus. As further evidence might be cited the fact that there are cases in which the embryo is destroyed very early, but in which an amount of amniotic fluid may be found corresponding, not to the age of the embryo, but to that of the ovum. And, moreover, it is not unusual to find hydramnion associated with some other serous effusion in the mother.[2]

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[1] Preyer: *Physiologie des Embryos.*

[2] Zweifel: "Untersuchungen über das Meconium," *Arch. f. Gyn.*, Bd. vii. 474.

[3] Fehling: *Arch. f. Gyn.*, Bd. xiv. S. 221.

That the fœtus also contributes to the formation of liquor amnii is demonstrated by the fact that the excretion of urine during the latter part of fœtal life reaches a considerable amount. Thus, more than three pints of urine have been found retained in the fœtal bladder.[3]

Gusserow[4] has injected benzoic acid into the mother, and recovered it as hippuric acid in the liquor amnii—a proof that it had passed through the kidneys of the fœtus; and Wiener has found sodium sulphindigolate in the fœtal kidneys and bladder after it had been injected into the maternal tissues. The constant presence of urea[5] in the amniotic fluid, at least after the sixth week, is an additional proof, if one were needed, of the renal activity of the fœtus. It is probable also that the vasa propria, discovered by Jungbluth[6] in the early life of the embryo lying close under the amnion, have something to do with the production of the amniotic fluid in the earlier periods of pregnancy. Prochownik[7] claimed that it was the skin of the fœtus that secreted the amniotic fluid during the early months of gestation; and there has since appeared corroborative evidence in regard to this particular function of the fœtal skin. There have been cases of hydramnion associated with morbid conditions of the skin, notably one instance observed by Budin[8] where the skin of the fœtus was the seat of extensive nævi.

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[1] Ahlfeld ("Ueber die Genese des Fruchtwassers," *Arch. f. Gyn.*, Bd. xiii. pp. 160–241) gives an ingenious explanation of the manner in which the maternal structures take part in the formation of the liquor amnii: As the uterus develops by an eccentric hypertrophy, the pressure within the uterine cavity becomes less than that of the abdominal cavity, and consequently there is a disposition for the serum of the maternal blood to exude into the amniotic cavity. As Phillips (*Edin. Med. Journ.*, March, 1887, p. 811) remarks, however, the case of hydramnion in extra-uterine pregnancy (*Arch. f. Gyn.*, Bd. xxii. p. 57) reported by Teuffel would seem to invalidate this theory.

[2] *Pflüger's Arch.*, Bd. xvi. S. 548; and Wiener, *Arch. f. Gyn.*, Bd. xvii. S. 24.

[3] Lefour: *Arch. de Tocol.*, June 30, 1887.

[4] *Arch. f. Gyn.*, xiii. S. 56.

[5] Prochownik: *Arch. f. Gyn.*, Bd. xi. S. 304–561.

[6] *Beitr. zur Lehre v. Fruchtwasser*, Inaug. Dissert., Bonn, 1869; *Virchow's Archiv*, Bd. xlviii. S. 523; *Arch. f. Gyn.*, Bd. iv. S. 554.

[7] *Loc. cit.*

[8] Tarnier et Budin, *loc. cit.*, p. 279.

Thus it appears that the amniotic fluid is derived from a fœtal as well as a maternal source, but as to the relative importance of the fœtal or maternal supply of liquor amnii at different periods of pregnancy, we are still in doubt.

ABNORMALITIES OF THE AMNION.—One must be struck with the close analogy between the pathology of the amnion and that of the serous membranes generally. There is the same liability to changes of secretion, to inflammation with a plastic exudate, and the formation of bands of adhesion over a more or less extensive surface. The function of the amnion, however, and its close relation to the embryo and fœtus, give rise, in case of disease, to symptoms and results peculiar to itself.

*Abnormalities of Secretion.*—The quantity of liquor amnii varies, at term, between one and two pints (Gusserow). Occasionally, however, the quantity of fluid is very much below the normal—so much so in some cases as to seriously interfere with the growth of the fœtus and to determine its premature expulsion.[1] Schatz[2] reports a case in which there were ulcers on the inner surface of the knees and malleoli of a fœtus from constant friction due to a deficient quantity of liquor amnii, and many curious deformities of the fœtus may be traced to the same cause.[3] This condition goes under the name of *oligo-hydramnios.* More frequently the quantity of the liquor amnii becomes abnormally increased—a condition known as polyhydramnion, hydro-amnion, dropsy of the amnion, or, more commonly, hydramnion.

*Hydramnion.*—It has been already stated that the normal quantity of liquor amnii at the end of pregnancy is one to two pints. Should this quantity be much exceeded, the condition of hydramnion would exist. A slight excess is no doubt frequent, but would usually pass unnoticed, while an accumulation of fluid amounting to two quarts or more, which might perhaps inconvenience a woman, is not very common. It is difficult, therefore, to decide as to the relative frequency of hydramnion. Charpentier states that it occurs in 1 : 100 or 1 : 150 pregnancies—an estimate probably too low for the minor grades of the affection, but far too high for those more decided cases in which the accumulation of fluid is large enough to give rise to well-marked symptoms. In the majority of cases the fluid collects gradually, but steadily, until at the end of pregnancy it may reach the enormous quantity of six gallons or more.[4] Occasionally, however, the fluid accumulates very rapidly, giving rise, from the sudden distension of the uterus, to symptoms of a grave character. This is known as acute hydramnion.

*The Etiology of Hydramnion.*—The wide diversity of opinion in regard to the origin of hydramnion indicates plainly enough how indefinite is, as yet, our knowledge of the subject. In studying the source of hydramnion it is necessary to return to the study of the origin of the liquor amnii itself. The theories that at present prevail in regard to the formation of an excessive quantity of amniotic fluid may be thus classified: It may be due to (*A*) an over-secretion of liquor amnii, or to (*B*) a deficient absorption of the liquor amnii.

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[1] *London Lancet*, 1886, ii. p. 383.

[2] *Arch. f. Gyn.*, Bd. xix. S. 329.

[3] See Tarnier et Budin, p. 294.

[4] Wilson: *Am. Journ. Obstet.*, Jan., 1887, p. 22.

*A*. The excessive collection of fluid may be derived from (I.) a maternal source, (II.) a fœtal source, or (III.) both fœtus and mother may contribute to its production.

I. The hydramnion may have a maternal origin. That the serum of the maternal blood contributes to the formation of the liquor amnii has already been demonstrated; that it occasionally exudes in abnormally large quantities into the amniotic cavity is extremely probable. Thus in cases of hydramnion associated with serous effusions elsewhere in the mother's body the excess of liquor amnii is derived probably from a maternal source. Fehling,[1] who still adheres to his opinion that the liquor amnii is altogether a maternal production, says that "the thinner the maternal blood the greater is the quantity of liquor amnii." It would be well, therefore, to examine the blood of a patient who was affected with hydramnion, in order to detect a possible exaggeration of the usual hydræmia of pregnancy.

II. The hydramnion may originate entirely from fœtal structures. This supposition will explain by far the larger number of cases that admit of an explanation at all, for it must be remembered that hydramnion will often occur (44 per cent. of all cases—Bar) without a demonstrable cause in either mother or fœtus. The production of hydramnion being traced to the fœtus, it may be due to (*a*) abnormalities in the blood-vessels of the cord or of those directly under the amnion where it covers the placenta (persistence of the vasa propria of Jungbluth); (*b*) to an excessive urinary secretion; (*c*) to an abnormally great excretion from the fœtal skin.

(*a*) The vasa propria of Jungbluth, normally present in the early stage of embryonal development, have been found at term in cases of hydramnion,[2] and the production of an excessive quantity of liquor amnii has been attributed to their persistence. It is more probable, however, that the existence of these vessels is purely secondary, and that although the serum of the fœtal blood does exude from them into the amniotic cavity, their presence is due to an increased blood-pressure in the umbilical vein.[3] That increased internal pressure within the umbilical vein will give rise to a transudation through the amnion has been abundantly proved by Sallinger,[1] who found that the amount of fluid that would transude depended upon the strength of the pressure and the size of the cord. It may be generally stated, therefore, that any condition of the fœtus that will raise the blood-pressure in the umbilical vein, thus increasing the blood-pressure in the placenta, may give rise to hydramnion. This happens in those cirrhotic livers so common in syphilitic children, as may readily be imagined if one recalls the course of the umbilical vein after it enters the umbilicus. There are many other conditions having the same effect—a cord abnormally twisted, velamentous insertion of the cord (exposing the vein to external pressure), stenosis of the umbilical vein, obstruction of the ductus Botalli,[2] tumors of the placenta, tumors of the fœtus (interfering with its circulation), valvular defects of the heart,[3] etc.

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[1] *Arch. f. Gyn.*, Bd. xxviii. S. 454.

[2] Levison: *Arch. f. Gyn.*, Bd. ix. S. 517; Lebedjew: *Traité prat. des Acc.*, Charpentier, 1883, pp. 886, 890.

[3] Winckler denies the existence of a capillary system of blood-vessels under th amnion, and attributes hydramnion to the presence of a capillary lymphatic syste in the cell-layer of the chorion.

(*b*) Excessive excretion of urine as a cause of hydramnion. The action of the fœtal kidneys in the production of hydramnion can best be demonstrated in cases of unioval twins,[4] in one of which it is so common to find a dropsical amnion, while the other one presents usually the opposite condition, oligo-hydramnion. The history of these cases is that one fœtus outstrips the other in growth, and thus, acquiring a preponderating influence in the placenta which is common to both, its heart takes on an hypertrophy to enable it to carry on the greater part of the placental circulation. The hypertrophied heart produces in its turn hypertrophy of the kidneys, and determines their increased secretion. The increased blood-pressure also determines an increased activity of the excretion from the skin, and thus in a twofold manner helps to increase the quantity of liquor amnii.

(*c*) The fœtal skin is a source of hydramnion. It can readily be understood how an increased blood-supply from an hypertrophied heart can stimulate the fœtal skin to over-action. There are, however, more direct proofs of the part that the skin may play in the production of hydramnion. Budin[5] has described a case of hydramnion associated with extensive nævi, and another in which the skin was thickened and thrown into folds. Steinwirker[6] has recorded a case of hydramnios with "elephantiasis congenita cystica."

Finally, it is not improbable that the amnion itself can take an *active* part in the over-production of liquor amnii—that, in other words, the amnion may be affected by acute inflammation, amniotitis, followed by an increased serous exudation. This supposition would explain those cases in which a blow or a kick[1] on the abdomen of a pregnant woman is followed by the development of hydramnion and the formation of adhesions between the fœtus and the amnion. To amniotitis has also been attributed the development of acute hydramnion. Werth's[2] theory also deserves some consideration before leaving the study of the fœtal origin of hydramnion. This author believes that an hypertrophied placenta can absorb more fluid from the maternal blood than is required for the fœtal economy; that the struggle to get rid of this excess of fluid brings about that hypertrophy of the heart and kidneys to which reference has already been made as occurring especially in one of unioval twins.

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[1] *Ueber Hydramn. im Zusamm. mit der Entstehung des Fruchtw.*, D. I., Zürich, 1875.

[2] Nieberding: "Zur Genese des Hydramnion," *Arch. f. Gyn.*, Bd. xx. S. 275.

[3] Cordell: *Tr. Med. and Chirurg. Fac. Maryland*, 1884, p. 218.

[4] Schatz: *Arch. f. Gynäk.*, Bd. xix. S. 329; Werth, *Ibid.*, Bd. xx. 353; Sallinger, *loc. cit.*

[5] *Loc. cit.*

[6] *Loc. cit.*

III. Both fœtus and mother may contribute to the production of an excess of liquor amnii. This proposition has already been demonstrated in showing the possible derivation of the liquor amnii from both mother and fœtus. The cause of the hydramnion, however, will most frequently be found in the fœtus, while the combined action of both mother and fœtus in a single case will be rare, but may occur, as in certain cases of syphilis in which have been found combined dropsy of the mother and fœtus associated with hydramnion.[3]

*B.* Hydramnion may be due to a deficient absorption of liquor amnii: Tarnier believes that the production of liquor amnii being normal, but its absorption deficient, hydramnion will result. Thus he would explain the cases of hydramnion associated with nephritis and serous effusions in the mother.

It has been proven that the fœtus swallows the liquor amnii in considerable quantities, and it is possible that the skin absorbs some of it. Whether the cessation of these two functions would result in hydramnion is as yet uncertain.

*Symptoms and Diagnosis.*—The symptoms of hydramnion are very like those of other abdominal cystic tumors. There is, however, the history of pregnancy; the tumor can usually be defined as the uterus, very much larger than usual for the date that pregnancy may have reached; and, except in extreme cases, it is possible to detect the fœtal heart-sounds or to practise ballottement. As the uterus becomes more and more distended it gives rise, by its increased size, to pressure symptoms in the abdomen and thorax, although it is astonishing to what size the uterus may attain while the patient remains tolerably comfortable. This is not the case, however, when the liquid is rapidly effused, as in cases of acute hydramnion. Here the most serious symptoms may manifest themselves. The woman suffers intense pain from the sudden distension of the uterus. Her breathing becomes labored, and complete orthopnœa is developed; her face is cyanosed, and bears an anxious expression; constant and distressing vomiting appears; and there is fever.[1] The detection of hydramnion is not always easy, and may be practically impossible. It may be confused with pregnancy, associated with ascites, or with a cystic tumor of the ovary or broad ligament, or with an ordinary twin pregnancy; or the fact that the woman is pregnant may be entirely overlooked—a not uncommon mistake that has frequently led to the tapping of the pregnant uterus;[2] this procedure, however, would appear to be harmless. Finally, it might be possible to mistake the enlarged bladder associated with a retroflexed gravid uterus for a case of hydramnion (Tarnier). When the dropsy of the amnion has not reached an excessive degree, the distinction between it and ascites with pregnancy may be made by mapping out the uterine wall and detecting resonance along the flanks in the dorsal decubitus; and an ovarian cyst may be excluded by the absence of two tumors of different consistency and shape. A twin pregnancy without hydramnion will present, on external palpation, an enlarged uterus, offering firm but irregular resistance from its solid contents. In extreme distension of the uterus, which in bad cases seems only limited by the utmost capacity of the abdomen, a definite diagnosis becomes impossible: in such cases it might be advisable to resort to an exploratory abdominal section,[3] which has now become an operation of such slight danger.

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[1] *Tr. Obstet. Soc. of Baltimore*, meeting Feb. 9, 1887.

[2] Werth: *loc. cit.*

[3] Meissner and Hufeland, quoted by Wilson, *Am. Journ. Obstet.*, 1887, p. 13.

*Treatment.*—If the fluid should accumulate in such great quantity or so rapidly as to produce alarming symptoms in the woman, its evacuation would naturally be indicated. This is best accomplished by the natural passage; that is, by rupturing the membranes through the cervix and allowing the liquor amnii to escape. By this method, unfortunately, labor is induced, and if the child has not become viable its destruction is a necessary consequence. And, moreover, the sudden gush of liquor amnii from the uterus may induce syncope by the rapid removal of the intra-abdominal pressure. It has, therefore, been proposed (Guillemet, Schatz) that the uterus be tapped through the abdominal walls, and a moderate quantity of liquor amnii be removed from time to time, thus preserving the life of the fœtus. As, however, the fœtus in cases of hydramnion is often deformed or diseased, and usually dies shortly after birth, its life deserves little consideration in comparison with the additional risk that is undoubtedly entailed upon the mother by puncturing the abdominal and uterine wall. It is especially in acute hydramnion, as Charpentier insists, that puncture of the membranes will be called for, irrespective of the age or condition of the fœtus.

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[1] See Charpentier, *Traité pratique des Accouchements.*

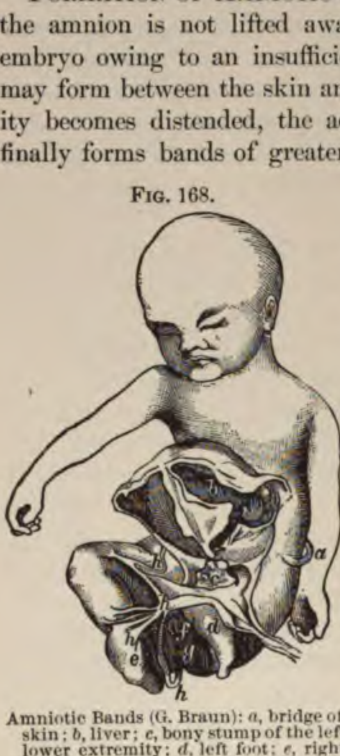
[2] Cases reported by Scarpa, Camper, Noël, Desmarais, Schatz, Tillaud, Chiara, Kidd, etc., not followed by the slightest bad results.

[3] Successfully performed in a case of extreme distension of the abdomen from hydramnion by Wilson, *loc. cit.*

Special instruments have been devised for the perforation of the membranes, and it has been suggested that the puncture be made at a point far within the uterine cavity, and thus removed from the external os, so that the liquor amnii may trickle slowly down between the membranes and the uterine walls, and the disadvantages of a sudden escape of the fluid be thus avoided. It is doubtful, however, if any better or more convenient appliance can be found than a stiff quill toothpick or a match sharpened at one end. The hand that is to use this simple instrument may be introduced into the vagina, so as to form a quite efficient plug, by means of which the operator may regulate at will the escape of liquor amnii. With this precaution it is immaterial whether the membranes be perforated during a pain or not.

FORMATION OF AMNIOTIC BANDS.—Early in embryonal life, in case the amnion is not lifted away from the newly-forming skin of the embryo owing to an insufficient secretion of amniotic fluid, adhesions may form between the skin and the amnion, and, as the amniotic cavity becomes distended, the adhesive material is stretched, so that it finally forms bands of greater or less length or thickness, either connecting the fœtus with the amnion or with one or other or both ends detached, floating more or less free in the liquor amnii. The composition of these bands closely resembles that of the plastic material thrown out in inflammations of the serous membranes generally. They are not provided with blood-vessels. The exudation of this plastic material from the amnion has as a result the formation occasionally of extensive adhesions between the fœtus and the amnion, resulting often in grave deformities, as eventration or anencephalus, by preventing the proper arching over of the body-cavities by the fœtal skin. The formation of adhesive bands, moreover, is most frequently followed by intra-uterine amputations, for a developing limb may be caught between two of these bands, and as it grows be so constricted that the distal portion of the limb is entirely cut off from its blood-supply. Adhesions may also be formed between various portions of the body and the amniotic

FIG. 168.



Amniotic Bands (G. Braun): *a*, bridge of skin; *b*, liver; *c*, bony stump of the left lower extremity; *d*, left foot; *e*, right foot; *f*, vulva; *g*, anus; *h*, amniotic bands.

covering of the placenta, or the umbilical cord may be artificially shortened by the adhesions of coils one to another and to the fœtal skin.[1]

In the latter part of pregnancy the amnion can burst, the integrity of the ovum being preserved by the chorion.[2] The fœtus then by its active movements can roll the amnion up into cords which can become so entangled with the umbilical cord as to constrict it sufficiently to shut off the blood-supply to the fœtus.

*Cysts of the Amnion.*—Cases of cystic formations in the substance of the amnion have been reported by Ahlfeld, Winckler, and Budin.[3] They are small, and must not be mistaken for cysts derived from the allantois, chorion, or those the result of an effusion of blood upon the placenta under the amnion. They have no clinical significance. After the death of the fœtus the amnion undergoes certain changes, resulting in a loss of its glistening surface, usually observed, and in a considerable thickening. The histology of this change is, as Tarnier remarks, little known.

## THE CHORION.

When the ovule first drops into the uterine cavity and becomes imbedded in mucous membrane, the protoplasmic cell-wall sends out numerous prolongations, which have the purpose of fixing the egg in its position, and perhaps of drawing nourishment for the whole ovum from the blood-vessels of the uterine mucous membrane. This cell-wall, with its villus-like projections, constitutes the false chorion, which is soon to disappear and be replaced by the single layer of cells springing from the outer layer of the blastodermic membrane and surrounding the whole ovum. This membrane in its turn sends out branch-like processes, the villi of the chorion, which, at first non-vascular but hollow, soon receive into the interior of each branch of the villi loops of the blood-vessels that have been carried from the fœtus to the periphery of the egg by the allantois.

These vascular villi, then, absorb nutriment from the whole extent of the decidua reflexa until the third month, when they atrophy and finally disappear, except at that portion of the periphery of the ovum which is in direct contact with the decidua vera (decidua serotina), where the chorion villi develop still further and form what is known as the placenta.

*The Fully-developed Chorion.*—Restricting the term *chorion* to that portion of the original membrane which undergoes atrophy at the third month of pregnancy, it is found to consist of a thin transparent membrane made up of connective-tissue elements which are continuous with the substance of the umbilical cord, and very delicate, atrophied villi connecting it with the decidua reflexa. This portion of the chorion is called chorion læve to distinguish it from the chorion frondosum, that forms the placenta. The fibrous membrane constituting what is usually called chorion at term is derived from the endochorion, so called to distinguish it from the outer epithelial layer, the exochorion, which is to be found persisting in the epithelial covering of the placental villi.

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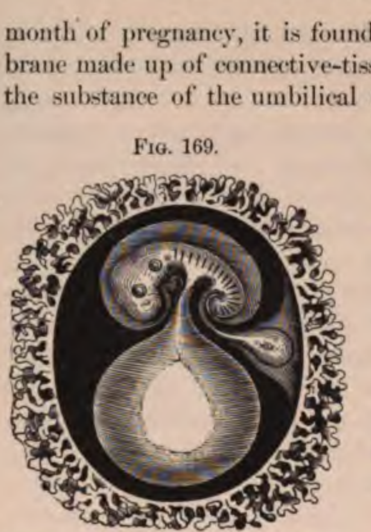
[1] Leopold: "Ein Fötus mit Verklebungen der Nabelschnur, etc.," *Arch. f. Gyn.*, Bd. xi. 383.

[2] Schroeder: *Lehrbuch*, 8th ed., p. 455.

[3] Tarnier et Budin: *loc. cit.*, p. 274.

FIG. 169.



Human Embryo at the Third Week, showing villi covering the entire chorion (Haeckel).

*Diseases of the Chorion.*—An abnormal condition of the chorion, but hardly to be classed as a disease, is the persistence of the chorion villi around the whole periphery of the ovum, thus completely enveloping the fœtus by the placenta.[1] If, however, instead of remaining normal in that they perform their physiological functions, the villi of the chorion undergo extensive degeneration, the consequences for the mother and fœtus, but especially the latter, are more serious. The degenerations, aside from the normal process of atrophy, that can affect the chorion villi are of two kinds—cystic and fibro-myxomatous.

*Cystic Degeneration of the Chorion Villi.*—This disease of the outermost of the fœtal envelopes is characterized by the hypertrophy of the chorion villi, by their conversion into cysts varying in size from that of a millet-seed to a grape or even to a hen's egg, connected with one another and with the base of the chorion by pedicles of greater or less breadth. It is further distinguished by the rapid growth of the ovum, and the consequent expansion of the uterus, usually at the third to the fourth month; by the early escape of blood from the uterine cavity into the vagina; and by the premature expulsion of the ovum, which is covered over a greater or less part of its surface with numbers of small, transparent cysts. Within the cavity of the ovum may or may not be found an embryo.

This affection of the chorion, from the peculiar and striking appearance that it gives to the ovum, has attracted much attention, and from the mystery that formerly surrounded its origin, and the difference of opinion that even yet exists as to its etiology and minute anatomy, cystic degeneration of the chorion villi, otherwise known as hydatidiform mole, vesicular mole, or dropsy of the chorion villi, has been the subject of much discussion. First definitely described by Schenk,[1] the most extraordinary theories have been advanced to account for its occurrence. Regnier de Graaf (1678) believed that each vesicle or little cyst was an unfecundated ovule. But much earlier than this the belief had prevailed, at least on one occasion, that each vesicle was a living embryo.[2] The opinion of Ruysch (1691) and Albinus (1754), that the existence of innumerable little cysts in the uterus and their final expulsion were dependent upon some disease or alteration of the ovule, became at last generally adopted. A more definite explanation, however, was not attempted until, in the early part of this century, it was claimed by Percy,[3] Cloquet,[4] and Boivin[5] that this vesicular disease depended upon the presence of echinococci. Velpeau[6] was the first to indicate that the cysts were nothing but the distended chorion villi—a fact that was soon acknowledged to be indisputable. Since this announcement of Velpeau's the cystic degeneration of the villi has been attributed to hypertrophy of the villi with œdema (Meckel, Gierse); to disease of the blood-vessels (Bartolin, Miller, Cruveilhier); to disease of the lymphatics (Bidlos, Sömmerring); to degeneration of the mucous substance within the villi, continuous with the substance of the cord (Virchow); and, finally, to a degeneration of the epithelial cells derived from the decidua, which replace the epithelial covering (exochorion) of the chorion (Ercolani). Virchow's[7] explanation is much the most satisfactory, and is the one generally accepted at the present time. According to this distinguished pathologist, the change that results in the cystic degeneration of the chorion villi takes place altogether in the endochorion, which forms the inner of the two layers that compose the chorion, and is continuous with the Wharton's jelly of the umbilical cord; this change consists in the over-production of true mucous tissue within the villi, into which the mucous tissue extends, at first alone, but afterward accompanied by blood-vessels. This process usually begins at a time when the villi are pretty equally developed over the whole ovum —that is, before the third month—and thus it is that when the vesicular chorion is expelled the disease is usually found equally distributed over the whole surface, showing no evidence of special development at any one point that might indicate where the placenta should have been situated. This general involvement of the whole chorion is the rule, but exceptionally it is the placenta alone that is affected, the disease having doubtless in such cases begun after the atrophy of the villi had taken place over the extra-placental portion of the chorion. Still more rarely will the disease be found in isolated spots upon the chorion læve.[1] But still more curious are those recorded cases in which one chorion of a twin conception was vesicular, while the other remained normal. It will be seen that according to this explanation the disease is a true myxoma of the chorion, and that the epithelial cells (exochorion) covering the villi do not necessarily take part in the morbid process. Priestley's[2] investigations, undertaken as long ago as 1858, gave results in accord with Virchow's theory: "The club-shaped extremities (of the villi) were observed to be distended with large nucleated cells," which were distended with fluid and were bounded by walls of extreme tenuity. As Priestley says, the discrepancy between his observation and Virchow's statement that the mucous tissue is contained in the intercellular substance is only apparent, for it is highly probable that the extreme distension of the cells by a gelatinous fluid is the first step in the formation of the mucous tissue, this being analogous to the production of Wharton's jelly in the cord.

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[1] See *Am. Journ. Obstet.*, 1886, p. 851.

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[1] See Tarnier et Budin, p. 299.

[2] See the interesting quotation by Priestley (*loc. cit.*, p. 36) from Ambroise Paré, "that the Countess Margaret . . . . brought forth at one birth 365 infants, whereof 182 were said to be males, as many females, and the odd one an hermaphrodite" (1276 A. D.).

[3] *Journal de Médecine*, t. xxii. p. 171, 1811.

[4] No. 1, *De la Faune des Méd.* (Priestley).

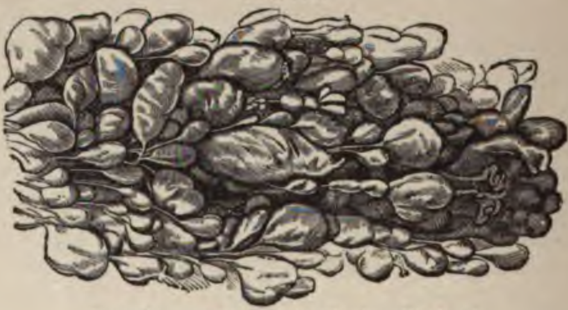
[5] *Nouvelles Recherches sur le Môle vésiculaire*, Broch., Paris, 1827.

[6] *De l'Art des Accouchements.*

[7] *Die Krankhaften Geschwülste*, i. S. 405.

*Pathological Anatomy.*—The appearance of a vesicular mole is striking and peculiar. The mass may be as large as a man's head, covered more or less completely with decidua, which upon incision, or in spots where the decidual covering is absent, reveals innumerable small cysts, some as large as grapes or even as hen's eggs, connected one with the other or with the base of the chorion by pedicles of varying thickness. The liquid content of the cysts is usually clear and translucent. A microscopic examination of a section through a villus in the early stages of cystic degeneration will show the distended cells of which Priestley speaks, or else there may be seen the outer cellular and inner fibrous walls of a villus, while within the interior will be stellate connective-tissue cells, in the interstices between which may be found mucous tissue.

FIG. 170.



Cystic Degeneration of the Chorion (Virchow).

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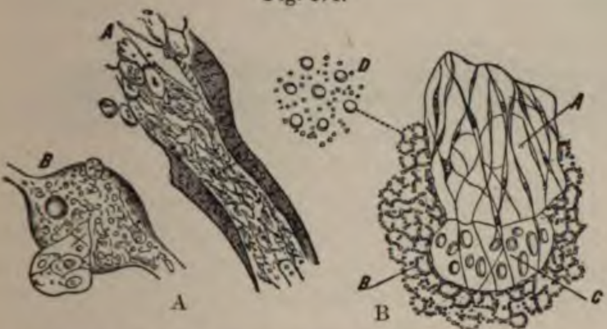
[1] Winogradow: *Virch. Arch.*, 1870, Bd. li. S. 146.

[2] *Loc. cit.*, p. 37.

The fluid contained in the cysts gives evidence on chemical examination of the presence of mucin and albumen in considerable quantities.

Fig. 171.



(A) Extremity of a Villus in Early Stage of Cystic Degeneration: *A* shows the first stage of enlargement in the cells of the villus trunk; *B*, a somewhat more advanced stage, showing hyaline cells escaping from the ruptured capsule of a young cyst (Priestley).
(B) Terminal Villus of Cystic Chorion: *A*, stellate connective tissue; *B*, *C*, inner and outer layers of wall; *D*, early stage of *B* (Braxton Hicks).

Within the centre of the vesicular mass is usually to be found a shrivelled or distorted fœtus surrounded by its amnion, which occasionally contains an abnormal quantity of fluid (hydramnion). Occasionally, however, no trace of an embryo is to be discovered, or at most there may be seen only the remnants of an umbilical cord. More rarely the fœtus, although dead, is apparently well developed for the date of pregnancy,[1] and if the degeneration of the chorion has not been too extensive, a living, healthy infant may be born along with a vesicular chorion.[2] It has been already noted that between amnion and chorion may be found a thin layer of jelly-like substance continuous with the Wharton's jelly of the umbilical cord. There is a case on record[3] in which this substance formed a layer 4 to 5 mm. thick originating from a mucous degeneration of the connective-tissue layer of the chorion, without involvement of the villi of either the chorion læve or frondosum, thus constituting a peculiar and, up to the present time, unique variety of myxoma of the chorion.

The relation of the cystic chorion to the two deciduæ is often peculiar and complicated. Occasionally the membranes retain their normal relative position of external deciduæ, median chorion, and internal amnion; but frequently the enlarged villi of the chorion perforate either one or both deciduæ over surfaces of varying extent. Thus, specimens have been described[4] in which the cystic mass was enclosed between the decidua vera and the reflexa, or in which the villi have perforated not only both deciduæ, but also the muscular wall of the uterus, and even its peritoneal covering.[1]

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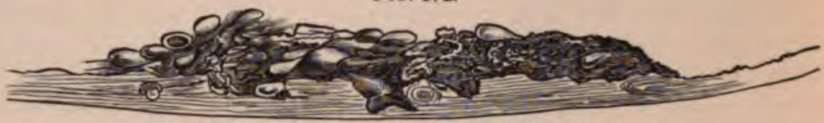
[1] Priestley: *loc. cit.*, p. 42.

[2] Schroeder: *Lehrbuch d. Geb.*, 8th ed., p. 442; and Sym: *Edinb. Med. Journ.*, Aug., 1887, p. 102.

[3] *Wiener Med. Presse*, 1867, i.; and *Virch. Arch.*, Bd. xxxix. H. 1.

[4] Priestley: *loc. cit.*, p. 40.

FIG. 172.



Cystic Chorion perforating the Uterine Walls (Spiegelberg).

*Clinical History and Diagnosis.*—There are three prominent symptoms associated with cystic degeneration of the chorion: (1) Rapid increase in the size of the uterus; (2) discharge of blood or bloody serum; and (3) the escape of vesicles. The last symptom is of rare occurrence, and the first two do not always manifest themselves in a typical manner, so that the clinical phenomena in a case of vesicular mole do not always permit of a definite diagnosis. Should there be an escape of blood at intervals during the early part of pregnancy, if the uterus rapidly enlarges toward the third month, and if careful palpation elicits no sign of the presence of a fœtus within the uterine cavity, the existence of a cystic chorion may be suspected. If, as rarely happens, characteristic cysts are expelled, there can be no doubt as to the nature of the case. Vesicular mole is most apt to occur in women who have already borne children or who have reached middle age. Hirtzmann[2] found that of 35 cases, 25 occurred in women over twenty-five years of age. As an exception to this rule, however, might be mentioned that authentic case described by Stricker[3] of precocious menstruation in a child who in her ninth year gave birth to a true vesicular mole. It is almost unnecessary to assert that, according to our knowledge of the formation of vesicular mole, it is necessarily a result of impregnation, and cannot occur in a virgin uterus—a fact that has proved of importance in deciding certain medico-legal questions. Cystic degeneration of the chorion will often occur in women who have previously given birth to healthy children, but it will not infrequently recur in the same individual. Depaul[4] mentions a woman who had this affection three times, and Mayer has[5] observed the disease in eleven successive pregnancies. The degenerated chorion usually determines the expulsion of the ovum at some period between the third and sixth months of gestation. If, however, the disease does not begin until after the villi of the chorion læve have atrophied, or if the degeneration is confined to a comparatively limited area, the pregnancy will usually go on to term. On the other hand, if the embryo is absorbed and the chorion becomes adherent to the uterine wall, the pregnancy may be abnormally prolonged to twelve or thirteen months (Schroeder). This adhesion of the cystic villi to the uterine wall has more serious results, however, than the mere prolongation of pregnancy. It is often due to the perforation of the uterine wall by the chorion villi, and consequently when the mass is expelled there may be fatal hemorrhage from the uterine sinuses (Volkmann, Waldeyer), or, as in Wilton's case,[1] the peritoneal covering may be torn and fatal hemorrhage ensue into the peritoneal cavity. Even if such serious accidents do not occur, the retention of a portion of the chorion may be followed by its decomposition within the uterine cavity, giving rise to general septicæmia. Or, as McClintock[2] pointed out, the fragments of cystic chorion retained in utero may go on proliferating, and may be expelled at a date remote from the original pregnancy. With these accidents, of not infrequent occurrence in the course of the disease, it is little surprising that the maternal mortality of cystic chorion is placed at more than 13 per cent.

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[1] Cory, quoted by Priestley, p. 41. Vollkmann, Waldeyer, Jarotzky, Krieger, Wilton, quoted by Schroeder, *op. cit.*, p. 444.

[2] *Thèse de Paris*, 1874.

[3] *Virch. Arch.*, Bd. lxxvii. S. 193.

[4] *Leçons de Clin. Obstet.*, 1872.

[5] Tarnier et Budin, p. 306.

*Etiology and Frequency.*—The occurrence of vesicular disease of the chorion cannot be attributed to any single cause, but, like hydramnion, the conditions which are responsible for its production are manifold, and may reside in either the mother or fœtus. The connection between disease of the endometrium (Virchow) or of the uterine walls (fibroid tumor—Schroeder) and vesicular mole is clearly established in a large proportion of the cases, especially in those in which there is a frequent recurrence of the disease; but this explanation will not suffice, as Priestley remarks, for the occurrence of the disease in the chorion of one fœtus while that of its twin remains healthy. In this case the disease is of fœtal origin, perhaps the result of the death of the fœtus. Indeed, it has been claimed (Graily Hewitt and others) that the death of the embryo necessarily precedes the cystic degeneration of the chorion. That this view is incorrect, however, is demonstrated by the birth of living children in certain cases of not too extensive degeneration of the chorion. It has been claimed also that vesicular mole is the result of an absence of the allantois (Hecker), or that possibly the allantois may, in certain cases, contain no blood-vessels (Schroeder), thus depriving the villi of their circulation.

Stenosis of the umbilical vein has been found associated with cystic chorion, and therefore it has been asserted that the cystic degeneration may have been due to dropsy of the chorion villi (Maslowski, Robin). As to the frequency of this affection there are no reliable statistics. Mme. Boivin saw the disease only twice in 20,375 pregnancies, while in the Charity Hospital[3] in Berlin it occurred four times in 2130 pregnancies. The truth lies nearer to the last set of statistics than to the first, for, as Priestley says, every obstetrician of large practice has seen at least one case. Perhaps once in two or three thousand cases would be the true indication of the frequency of this disease.

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[1] *Lancet*, Feb., 1840.

[2] *Clin. Mem.*, 1863.

[3] *Charité Annalen*, Bd. x.; *ib.*, xi.

*Treatment.*—The treatment of a pregnant woman affected with cystic degeneration of the chorion will be mainly directed toward the symptoms. Should there be excessive hemorrhage, it might be necessary to stop up the vagina with tampons until the os is sufficiently dilated to permit the expulsion of the cystic mass. If the diagnosis of cystic disease of the chorion should be made during pregnancy, and if abdominal or combined palpation gives no sign of the presence of a fœtus, the immediate induction of abortion would be advisable in order that the chorion might not have an opportunity to grow to inordinate size and push its way perhaps into the uterine wall, giving rise to hemorrhage or possibly to perforation of the uterus. After the expulsion of the diseased ovum, if there should be symptoms pointing to the retention and decomposition of fragments of chorion within the uterine cavity, the natural impulse would be to remove the offending substances; but it must be borne in mind that the attenuation of the uterine wall in circumscribed areas may be so great that the slightest interference, the introduction of a curette or the injection of an antiseptic solution, may cause its rupture with a fatal result.[1]

FIBRO-MYXOMATOUS DEGENERATION OF THE CHORION.—If, instead of being thin and watery, the mucous tissue in the intercellular spaces of the degenerated villi should contain more fibrous elements, the resulting mass, instead of being cystic, would be solid. Virchow[2] first called attention to this condition in the placenta, and gave it the name of myxoma fibrosum placentæ. In this case, the first one described, in the midst of healthy cotyledons one was discovered affected by this fibro-mucous degeneration. A similar structure may be found in the peripheral layers of the umbilical cord.

To complete the study of diseases of the chorion it only remains to mention briefly a chronic inflammation of the membrane.[3] In that case, already referred to, in which the amnion was ruptured during pregnancy, the irritating effect of the liquor amnii upon the chorion produced a thickened and hyperplastic condition of that membrane.

## THE PLACENTA.

The placenta, as a separate organ, may be said to date from the third month of pregnancy, for it is at that time that the chorion villi atrophy over the whole periphery of the ovum, except at the point where it comes in direct relation with the true mucous membrane of the uterus, that portion of the decidua vera which goes under the name of decidua serotina. Here the villi take on an extraordinary growth, sending out branches in every direction, into each of which a loop of blood-vessels is projected. Separating the villi from one another, and dipping down to the base of the chorion between the parent stems of the villous projections, are at first capillary loops, and afterward large blood-spaces, containing maternal blood. So far, almost all authorities are agreed, but as to the relation of the terminal villi to the uterine mucous membranes, as to the action of the chorional and decidual epithelium, and in regard to the changes that convert the uterine capillaries at first surrounding the villi into the large blood-sinuses that are later found in the placenta, many conflicting theories have been advanced. In regard to the relation between the placental villi and the uterine mucous membrane it has been variously stated that the former enter the mouths of the uterine glands (Bischoff); that they sink into crypts in the uterine mucous membrane which are new formations especially adapted for their reception (Turner); that the villi do not sink into glands or crypts, but are intimately invested with a layer of decidual epithelium (Ercolani); and that this epithelial covering acts as a glandular structure, secreting from the maternal blood a peculiar substance, the so-called "uterine milk," which acts as nutriment for the fœtal blood (Ercolani, Hoffmann).[1] It is now well enough established, however, that the placental villi imbed themselves in the soft interglandular substance of the decidua serotina, and that the uterine epithelium rises up in embankments around them, the decidual and the chorional epithelium remaining, however, distinct from one another. The uterine mucous membrane at this early period is richly supplied with capillary blood-vessels, from which loops are thrown around the villi in such fashion as to form a complex but very distinct network throughout the placental mass (Priestley). Later, these capillaries disappear, and in their place are seen the large sinuses, to which blood is conveyed from the maternal circulation by little curling arteries that wind their way up through the decidual epithelium and empty directly into the placental sinuses. These arteries are provided with only a delicate endothelial wall. Whether, now, the placental villi projecting into these sinuses are directly bathed in the maternal blood, or whether they are invested with an endothelial covering derived from the maternal blood-vessels in addition to their proper epithelial covering, is a matter still in doubt, although most careful observers have failed to detect this double investment of the villi. However this may be, it is unnecessary to say that the fœtal blood cannot possibly mix with the maternal blood, but that the former derives oxygen and nutriment through the medium of the epithelial cells (exochorion) that surround each villus and which clothe the parent trunks and the base of the chorion. This epithelial covering of the villi undergoes some remarkable changes during the development of the placenta. It becomes irregularly thickened, and in the thickened parts undergoes hyaline degeneration, producing the canalized fibrin first accurately described by Langhans.[1]

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[1] For a case resulting fatally after the injection of perchloride of iron see Priestley, *loc. cit.*, p. 41.

[2] *Op. cit.*, S. 414.

[3] Lebedeff, quoted by Tarnier, *op. cit*, p. 313.

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[1] For the sake of clearness, but at the risk of being pronounced dogmatic, the writer has refrained from giving an analysis of the controversial papers that have appeared on this subject, but will endeavor to succinctly state the theory as to the development of the placenta—that is, to the best of his belief, as nearly correct as possible with the present extent of our knowledge of the subject.

*The Fully-developed Placenta.*—The placenta after its expulsion from the uterus is seen to be a somewhat oval-shaped mass, measuring about 7 inches in its longest diameter, being about $\frac{3}{8}$–1 inch in thickness at the point of insertion of the cord, and weighing about 16 ounces. Upon that surface of the placenta into which the cord enters is seen a smooth, shining membrane continuous with the sheath of the cord, the amnion. This surface, the fœtal side of the placenta, contrasts strongly with the opposite, the maternal surface. This is of a dark-red hue, divided by deep sulci into lobules of irregular outline and extent, the cotyledons. Over the maternal surface of the placenta is stretched a delicate, grayish, transparent membrane, which is made up of the cells that compose the upper layer of the decidua serotina. This constitutes the maternal portion of the placenta. It will be seen, therefore, that in separating from the uterine wall the line of separation is not found to divide the fœtal from the maternal structures, but to be in the mucous membrane of the uterus, in the lower portion of the cellular layer of the decidua—a point to be more fully referred to later under the title of "The Deciduæ." Around the periphery of the placenta may be seen a large vein, the circular vein of the placenta, which returns a part of the maternal blood from the organ, the rest returning to the maternal circulation by means of the continuity between the placental lacunæ and the uterine sinuses. The situation of the placenta within the uterus may with equal frequency be found either upon the posterior or the anterior wall—occasionally, however, upon one of the lateral walls, more frequently the right (Schroeder).

A perpendicular section through the middle of a placenta which is still attached to the uterine wall will reveal the most intimate connection between the two. So close, indeed, is the connection between placenta and uterus that, as has been said, the line of separation when the placenta is cast off is found in uterine tissue. This close adhesion between the fœtal and the maternal portions of the placenta is explained by Langhans, who calls attention to the manner in which the delicate terminal villi, and even branches of a millimeter in thickness, are imbedded in the upper portion of the decidua, and held in place by their extremities bulging out into club-shaped masses, so that the exercise of considerable force will not extract them from the uterine mucous membrane, but will, instead, always lacerate the maternal structures.

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[1] See Minot: *Boston Med. and Surg. Journ.*, June 2, 1887.

FIG. 173.

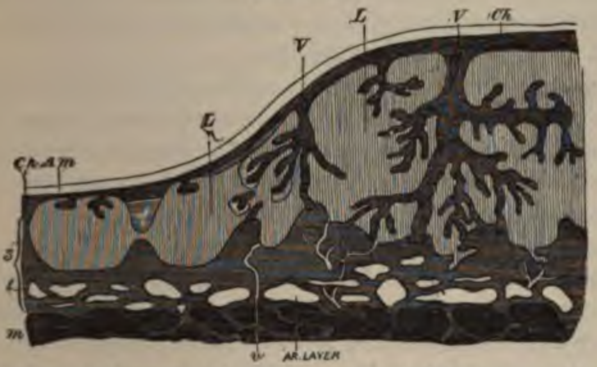

Diagram of Uterus and Placenta in the Fifth Month: *Ch*, chorion; *Am*, amnion; *V*, villi; *L*, lacunæ; *s*, serotina; *ar*, areolar; *v*, small arteries (Leopold).

The functions of the placenta are manifold. Not only does it act as a lung, or rather gill, in oxygenating the fœtal blood, but it may be said to take the place of the alimentary tract in absorbing nutritive material from the maternal circulation.[1] It is probable, moreover, that it plays the part of an excretory organ, getting rid not only of the surplus carbonic oxide gas in the fœtal blood, but also of the other waste products of a tissue-activity that in the rapidly-growing fœtus must be so great. Indeed, a very plausible explanation of the albuminuria and kidney diseases that are so frequent in pregnant women has been based upon the supposition that during pregnancy the maternal kidneys are called upon to get rid of the waste products of two organisms. As Bernard has shown that in the earlier months of pregnancy the placenta has a glycogenic function, we must regard it at this time also as a vicarious liver. The epithelial cells of the chorion villi must, however, take something more than a passive part in the passage of substances to and fro between the fœtal and the maternal blood. This is proven by a fact to which attention will later be called; that is, the comparative ease with which certain pathogenic micro-organisms—as, for instance, those of variola—pass from mother to fœtus, while the bacilli of tuberculosis, a disease often present in pregnant women, are almost never found in the fœtus; and also that certain drugs (iodide of potassium, benzoic acid, bichloride of mercury) enter the fœtal from the maternal blood, while it is asserted that others, as woorari, will not pass to the fœtus from the mother. Again, while nutritive material must pass from mother to fœtus, the escape of the same material from the fœtal into the maternal blood would prove destructive to the fœtus. It would seem, therefore, as if a limited power of selection must be attributed to the chorional epithelium.

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[1] It has recently been reasserted that the only function of the placenta is that of a lung or gill, and that the fœtus is nourished altogether by swallowing or absorbing through the skin amniotic fluid (v. Ott, *Arch. f. Gyn.*, Bd. xxvii.).

ANOMALIES OF THE PLACENTA.—The placenta may present deviations from the normal in regard to size, position, shape, weight, or number, or its structure may present anomalies the result of diseases or accidents; and as a further result of the same cause there may be anomalies of function.

*Anomalies of Position, Size, and Weight.*—The position of the placenta is normally near the fundus uteri. A lower insertion will, all the more surely as it approaches the internal os, give rise to the condition known as placenta prævia, to be more fully described in its appropriate place. The size of the placenta may vary considerably. As Schroeder says, the thickness of the organ will be in inverse ratio to its extent, and the younger the ovum the greater is the relative size of the placenta. The placenta, instead of being confined to that portion of the ovum which is in contact with the decidua serotina, has been known in rare cases to extend around its whole periphery. This condition is known as *placenta membranacea*, and is to be explained, of course, by the equal development of all the chorional villi. On the other hand, the placenta may be abnormally thick and enlarged in all directions, owing to an irritation from a chronically inflamed endometrium, which results in a hyperplastic condition of both the maternal and fœtal portions of the organ. Such a placenta may give rise to hydramnion by the excessive extent of its secreting surface. An abnormally small placenta may be associated with an ill-developed child or may depend upon an interstitial overgrowth with subsequent retraction, or upon atrophy of the decidua.

*Anomalies of Shape and Number.*—The placenta, usually round or oval, may have a horseshoe or crescentic shape, especially if it is inserted near the internal os, which in these cases is surrounded by the two arms of the crescent. A single child may have two (*placenta duplex*), three (*placenta tripartita*), or more (*placenta multiloba*) placentæ. Or a single placenta may be reinforced by one or more small accessory placental developments (*placentæ succenturiatæ*), which are in in direct communication with the blood-sinuses of the decidua vera. Should the villi of these accessory growths not communicate with the maternal blood, the growths are called *placentæ spuriæ*.

DISEASES OF THE PLACENTA.—The pathology of the placenta is already complicated, the morbid conditions that may be discovered being most diverse in their etiology, mode of development, and minute anatomy, so that it is no longer possible to admit, as was once asserted, that there is only one morbid process to be studied in the placenta—a fibro-fatty degeneration.

*Œdema of the Placenta.*—A serous infiltration of the whole placenta is often observed in those cases in which a dead fœtus has been retained some time within the uterus, and has become macerated.[1] The same condition is often found associated with general anasarca of the fœtus, with some obstruction of the umbilical vein or of the venous system of the fœtus, or with a greatly hypertrophied placenta which absorbs more fluid than the fœtal economy can dispose of (Werth). The minute anatomy of the placenta can remain normal in this disease, and the placenta may continue to perform its physiological functions.

DEGENERATION OF THE PLACENTAL VILLI.—The morbid processes that result in such grave alteration in the structure of the placental villi as to abrogate their physiological activity are of radically different natures, and may best be studied separately under their respective titles of cellular hypertrophy, fibrous and fatty degeneration, phthisical placenta, and calcareous and myxomatous degenerations. Placental hemorrhages, placental syphilis, and solid tumors of the placenta have, as a result, the destruction of all or a part of the placental villi as factors in the nourishment and aëration of the fœtal blood, but these conditions will be considered separately.

*Cellular Hypertrophy.*—Ercolani[2] has described, under the name of "cellular hyperplasia and hypertrophy of the parenchyma of the placental villi," a disease that is characterized by the extensive multiplication of the cellular elements in the villi to such an extent as often to obliterate the blood-vessels and give the placenta a hard, dense appearance and feel that has been called by other writers sclerosis of the placenta, and has been attributed to the over-production of fibrous tissue. Cellular hypertrophy may also be seen in syphilitic disease of the villi.

*Fibrous and Fatty Degeneration of the Placenta.*—A fibrous and fatty change in the placental villi is extremely common, and isolated examples of it may be found in almost every placenta, especially toward the periphery of the organ. It is necessary to consider the two together, for they are always found in common, except when the degeneration of the placenta follows the death of the fœtus. In this case there is a simple fatty change without other pathological process (Barnes). It has been claimed by some observers, as Barnes[3] and Kilian,[4] that fatty degeneration of the placenta may be the primary pathological process, and may originate independently of other degenerative changes; and it has also been asserted that this degeneration is only an exaggeration of the condition that normally obtains in the placenta toward the end of pregnancy; but most modern investigators will agree with Robin and Ercolani that the fatty change is subsequent to other degenerative processes, most frequently an abnormal development of fibrous tissue—a condition that might be termed interstitial placentitis. This development of fibrous tissue must be carefully distinguished, however, from the fibrous change that occurs in blood-clots due to effusion from the maternal capillary loops in early pregnancy, or to thrombosis in the placental lacunæ later on. In accordance, then, with the belief that a fibrous change usually precedes the fatty degeneration, it will be well to first glance at what has been called interstitial placentitis, but which has been also variously named sclerosis of the placenta, or by earlier writers scirrhous, tuberculous, or cartilaginous degeneration. The fact that an inflammation of the placenta can occur has been denied, for there are no capillaries in the maternal portion, nor are there nerves to govern the dilatation of the capillaries in the fœtal tufts; and therefore the present accepted theory in regard to inflammation cannot be applied to the placenta. But as the process that ends in the over-production of connective tissue is precisely analogous to what occurs in cirrhosis of the liver or in fibroid phthisis in the lungs, it would seem that the theory, and not the facts, is at fault. The fibrous change, consisting in the displacement of the normal structures by fibrous tissue, by the atrophy of the former either from the pressure exerted by the hypertrophied fibrous elements or by their subsequent contraction, may originate either in the decidua serotina, the placental villi, or the intervillous spaces.

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[1] Tarnier et Budin: *op. cit.*, p. 329.

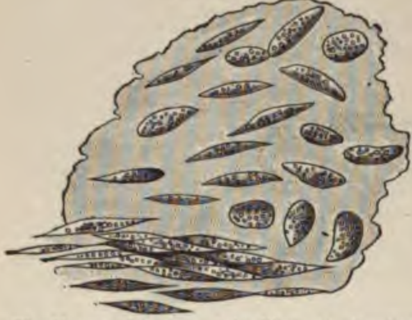
[2] *Delle Malattie della Placenta*, Bologna, 1871.

[3] *Med.-Chir. Trans.*, 1851.

[4] *Neue Zeitschr. f. Geburts.*, 1850.

When the disease affects the decidua serotina, it is associated with chronic inflammation of the remainder of the endometrium, and it would be better perhaps, with Braun, Schroeder, and Spiegelberg, to regard this not as a disease of the placenta, but as an endometritis. As the disease progresses, however, the placenta becomes secondarily involved, either by the encroachment of the hypertrophied decidua upon the intervillous spaces, and the consequent compression of the villi, or by the agglutination of the different layers of the membrane one to another, which may result in the firm adherence of the placenta to the uterine wall. Hegar and

Fig. 174.



The Maternal Portion of the Placenta, showing elongated decidual cells, the first step in interstitial placentitis.

*Maier*, and many others since them, have described this disease as *interstitial* endometritis.[1]

The same microscopic appearance may be seen in an hypertrophied decidua throughout its extent, and is not confined to the placental site. It is, however, possible to find an endometrium in an advanced stage of hyperplastic inflammation, while the upper layer of the decidua serotina remains unchanged, even although the placental site itself is immensely thickened by new-formed connective tissue and enlarged blood-sinuses. In such a case, an example of which I have seen, the placenta remains unaffected.

The fibrous degeneration may have its seat in the placental villi alone. The process that transforms a healthy villus containing blood-vessels into a bundle of connective tissue can well be studied in the extra-placental villi of the chorion, which normally undergo a fibrous degeneration as they begin to atrophy at the third month of pregnancy. The mucous tissue in the interior of the villi becomes converted into fibrous tissue, the blood-vessels are obliterated, and the villi shrink, atrophy, and become more or less infiltrated with fat. This same process may be seen in isolated villi of almost every placenta. If the process becomes more extended, the functions of the placenta are naturally abrogated. According to Ercolani, the cellular covering of the villus also takes an active part in its fibrous transformation. According to Neumann,[2] the interchange between fœtal and maternal blood may be prevented by the great hypertrophy of the placental villi, and their consequent encroachment upon the maternal blood-spaces.

The development of connective tissue may take place in the intervillous spaces—a condition to be carefully distinguished from the fibrous mass that results from the effusion of blood or the occurrence of thrombosis in the same situation. The development of the fibrous tissue has been ascribed by Simpson, Rokitansky, Scanzoni, Priestley, and others to an inflammation followed by an exudate which organizes into connective tissue. Priestley has recently described, under the name of placental phthisis, a pathological condition of the placenta brought about in this way: The first stage of the disease, says this author, consists of an exudation or deposit thrown out among the villi, probably due to some modification of a low inflammatory process, the result of which is a sort of "hepatization" of the part affected. The mass thus formed either remained dense and firm throughout, or else in the centre might be found a crumbled and disintegrated substance resembling the result of cheesy degeneration of tuberculous masses in the lung. As a result of this disintegration there may be found evidences of hemorrhages in blood-clots at different stages of organization.

The result of fibrous degeneration of the placenta, wherever the disease originates, is to prevent the performance of its most important vital functions, and if the pathological condition involves a large area of the organ, it must prove destructive to the fœtus. The deprivation of their blood-supply determines the fatty degeneration, or in some cases amyloid degeneration,[1] of the placental villi. This fatty infiltration is the more marked, as a rule, the older the original lesion. Thus, Bustamente's[2] description of a "sclerotic" placenta as presenting a reddish, flecky, lobulated, or smooth mass resembling the thymus would be applicable to a fibrous placenta in which fatty degeneration had not advanced very far. In the latter case the organ would present a paler, yellowish hue. The diagnosis of fibro-fatty degeneration of the placenta is impossible during pregnancy. Such a condition may be inferred if there is a history of the previous repeated occurrence of the disease. It was in such cases especially that Simpson recommended the administration of chlorate of potassium.

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[1] *Virch. Arch.*, 1871.

[2] See Priestley: *loc. cit.*, p. 54.

*Myxomatous Degeneration.*—The myxomatous degeneration that has already been studied in the chorion villi may be confined to the placenta, while the extra-placental chorion remains healthy. Myxoma fibrosum placentæ has already been described. This affection has been observed by Virchow,[3] Storch (2 cases),[4] Hildebrandt,[5] and Sinclair;[6] and, as Priestley says, the case of sarcoma of the placenta described by Hyrtl should be placed under this head. In this category also, according to Schroeder, should be placed the tumors of the placenta described by Clarke[7] and Löbl.[8]

*Calcareous Degeneration.*—Depositions of small quantities of lime in the placenta are not at all uncommon. They are usually to be found in that portion of the maternal placenta lying nearest the villi, or they may originate in the villi themselves. Chambord[9] has found as many as five hundred concretions in one placenta. It has been said that extensive calcification of the placenta is more apt to occur after the death of the fœtus, but Tarnier asserts that there is no relation of cause and effect between the two, and that the occurrence of large calcareous deposits in the placenta with stillborn children is a mere coincidence, as it is also in those cases in which calcareous degeneration has been associated with syphilis.[10]

*Placental Syphilis.*—Whether there is a form of diseased placenta that is peculiar to syphilis, and is found associated with no other con-

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[1] Green: *Am. Journ. Obstet.*, 1880, p. 279.

[2] *Thèse de Paris*, 1868.

[3] *Loc. cit.*, p. 414.

[4] *Virch. Arch.*, 1878, und Breus' *Wiener Med. Wochenschr.*, 1881, No. 40.

[5] *Monat. f. Geb.*, Bd. xxxi. S. 346.

[6] *Journ. Obstet. Soc.*, Boston, 1871.

[7] *Phil. Transactions*, London, 1798, ii. p. 361.

[8] *Zeitschr. d. Ges. d. Wiener Aerzte*, 1844, S. 231.

[9] *Lyon Médical*, 1873, p. 431.

[10] See also Fränkel, *Arch. f. Gyn.*, Bd. ii. S. 373; Winckler, *Arch. f. Gyn.*, Bd. iv. S. 260; Langhans, *Arch. f. Gyn.*, Bd. iii. S. 150.

*dition*, is a question which according to Tarnier, Depaul,[1] and Priestley[2] remains as yet unsettled. That the placenta, however, is often, if not uniformly, the seat of morbid processes when the mother or the fœtus is syphilitic is now no longer doubted; but the point at present in dispute is in regard to the specific and characteristic nature of the lesions to be found in the placenta in such a case. The investigation of this subject is of quite recent date. From the end of the last century, when Astruc first called attention to the fact that syphilis of either parent was apt to result in the birth of stillborn and macerated children, until the appearance of D'Outrepont's paper[3] in 1830, the opinion prevailed that the cause of the repeated fœtal deaths must be sought for in syphilitic disease of the viscera. It was this last-named author who first called attention to the influence of diseases of the placenta upon the nourishment and the life of the fœtus. Shortly afterward followed Simpson's well-known work,[4] and ever since all pathological conditions of the placenta have been investigated with increasing care, and the changes associated with syphilis have received especial attention. Virchow was the first to divide the study of placental syphilis into the investigation of the lesions in the maternal and in the fœtal portion of the organ, and to consider apart the changes in the decidua serotina (endometritis placentaris gummosa) and those in the extra-placental decidua (endometritis decidualis). No considerable advance was then made in the knowledge of placental syphilis, although the subject was investigated by many observers, until Slavjansky and Kleinwächter[5] called attention to the development of fibrous nodes "of a syphilitic nature" in the fœtal portion of the placenta, and the degeneration of the epithelium in the placenta materna. In 1873 appeared Fränkel's well-known paper, in which this author claimed to be the first to demonstrate that the "deforming granular hyperplasia and hypertrophy of the placental villi," already described by Ercolani—without, however, reference to its connection with syphilis—was the most frequent form of placental syphilis.

According to Fränkel, this infiltration of the villi with granulation-cells, and their consequent increase in size and distorted shapes, are characteristic of syphilis, and might serve to make certain the diagnosis of the disease. As to the seat and extent of the lesion, they vary with the manner and time of the fœtal infection. If the ovule is infected by the impregnating spermatic particle, the placenta, if diseased at all, will constantly present the granulation-cell infiltration of the villi and the degeneration of their epithelial covering. If the mother is infected during the fruitful coitus, there may be endometritis placentaris, characterized by the enormous overgrowth of the decidual cells or the overgrowth of connective tissue, as well as syphilitic disease of the villi. If the mother is syphilitic before conception, the disease of the placenta takes the form of endometritis placentaris gummosa. If the mother is infected during the later months of pregnancy, the placenta usually remains unaffected. Fränkel bases these conclusions upon the examination of more than one hundred specimens, and his views have been confirmed by Hennig[1] and MacDonald.[2] Specimens of syphilitic placentæ in my possession show very well the condition of the villi described by Fränkel, but exhibit even more clearly the condition of the placenta materna known as endometritis placentaris gummosa, in which the decidual cells are enormously increased and overgrown, encroaching deeply upon the intervillous spaces and undergoing in places cheesy degeneration. In one case, in which the mother was infected at about the fifth month of pregnancy, the placenta materna at birth was greatly thickened, and showed under the microscope an extraordinary development of connective tissue. The fœtal placenta and the child itself were perfectly healthy.

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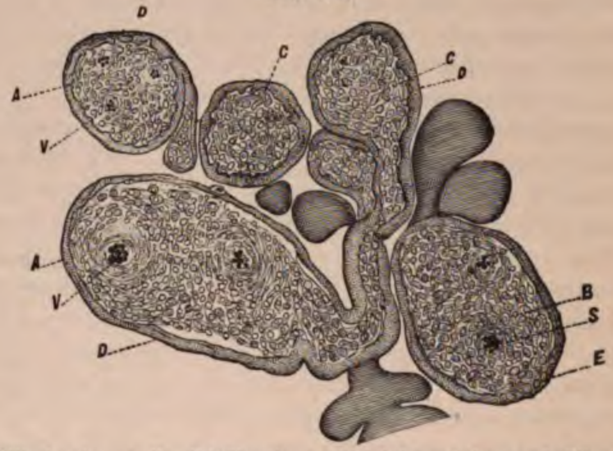
[1] Tarnier et Budin: *op. cit.*, p. 40. [2] *Loc. cit.*, p. 63.

[3] "Ueber die Krankheiten u. Abnorm. der Placenta," *Gem. Deutsche Zeitschr. f. Geburtsh*, Bd. v. 518.

[4] *Edin. Monthly Journ. of Med. Sci.*, Feb., 1845; *Obstet. Works*, vol. ii. p. 445.

[5] See Fränkel: "Ueber Placentar Syphilis," *Arch. f. Gyn.*, Bd. v. S. 6.

FIG. 175.



Section of Villi, showing small cell-infiltration and the deformed shapes of villi: *A A*, luxuriant cell-development in the interior; *V V*, lumen of blood-vessels with hypertrophied walls; *B*, villus in which only a trace of blood-vessels can be seen at *S S*; *C*, villus without trace of vascular canal; *D*, epithelial covering (Fränkel).

In their macroscopic appearances syphilitic placentæ can differ considerably. If the child has been dead some time, the placenta may be almost white in appearance and soft and greasy in feel.[3] If the child is expelled alive at term, the placenta is often unusually large and of a pinkish color, due to the thickened decidua, which prevents the true color of the organ from appearing. Very often there are organized clots, showing a previous hemorrhage into the placenta or the occurrence of thrombosis in the lacunæ; or else there may be found nodes[1] of a greater or less extent, lamellated in structure, and undergoing degenerative changes in the central portions. Often, too, there is found extensive calcareous degeneration of the organ, but Tarnier says that this is a mere coincidence.

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[1] *Arch. f. Gyn.*, Bd. vi. S. 141.

[2] *Br. Med. Journ.*, Aug., 1875, p. 234.

[3] Charpentier: "Syph. héréditaire," 1870, *Presse Méd. Belge*, No. 8.

The consequence of syphilitic disease of the placenta is usually disastrous to the fœtus and often dangerous to the mother. The cellular infiltration of the villi results in the obliteration of the blood-vessels within them, and consequently makes the performance of their functions impossible. The same effect may be produced by the hyperplasia of the decidua serotina and the consequent encroachment of the decidual tissue upon the intervillous blood-spaces, or the destruction of the villi may be brought about by the formation of the nodular masses that have been noticed. All these processes, if, as is the rule, they invade the whole area of the placenta, must of necessity be fatal to the fœtus. The endometritis placentaris that is often a prominent feature of placental syphilis may prove dangerous to the mother by so matting the different layers of the placenta together as to occasion a close adherence of that organ to the uterine wall, thus subjecting the woman to the perils of hemorrhage, septicæmia, or inversion of the uterus that are incidental to adherent placentæ.

The accurate diagnosis of placental syphilis is impossible during pregnancy. This condition may be inferred with considerable certainty, however, should a history of syphilitic infection be obtained from either parent.

The treatment will be referred to later under the head of Fœtal Syphilis.

*Placental Hemorrhages.*—The term placental hemorrhage is used to indicate those circumscribed collections of blood that have undergone more or less marked change so frequently found in the placenta. The blood may be found in the shape of a fresh clot, sometimes occupying a very large area, especially in those cases in which abortion occurs as a result of the hemorrhage, or the extravasated blood may be encapsulated, surrounded by a fibrous wall of varying thickness, within which may be found a reddish or a brownish fluid, or the cyst may contain nothing but clear serum, while the coloring matter of the blood is deposited upon the cyst-wall or upon the surrounding villi.[2] The encysted hæmatocele, on the other hand, may contain large numbers of white blood-corpuscles undergoing fatty degeneration, giving rise to a liquid resembling pus. It is such cases, according to Tarnier, that have been described as abscesses of the placenta by Brachet, Cruveilhier, O'Farrell, and Simpson.

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[1] Zilles: *Studien über Erkrankungen der Placenta, etc.*, Tübingen, 1885.

[2] Ercolani has described a case of "placental melanosis" in which there was no trace of blood-extravasation, but the villi were infiltrated with pigment-granules (*Arch. de Toc.*, 1876, p. 193).

Again, the fibrin may predominate, especially in those cases of thrombosis in the placental sinuses described by Bustamente[1] and Slavjansky,[2] when, if the clot is slowly formed, the resulting mass will consist of laminated fibrin, such as one sees in aneurisms undergoing obliteration. In other cases the serum is rapidly absorbed, and there is left a mass of red globules containing white corpuscles, either aggregated together or scattered through the mass. Finally, the clot may organize through the process described by Weber and confirmed by Virchow, and thus form a distinct neoplasm in the placenta. The placental villi surrounding the extravasated blood usually undergo a fibro-fatty change.

The causes of placental hemorrhage are manifold. The predisposing causes may be stated to be those that lead to apoplexies elsewhere in the maternal system, as congestions (Simpson) or albuminuria (Winter, Fehling); the slow-moving blood-current in the placental sinuses and the excess of fibrin in the blood of pregnant women, predisposing to thrombosis (Bustamente); and diseased conditions of the placental villi (Charpentier and others). The determining cause may be a sudden, powerful action of the heart, producing at the same time perhaps apoplexy of the placenta and the brain; or syncope, favoring the formation of a thrombus; or external violence. In the early months of pregnancy it is more frequently a true apoplexy that gives rise to the hemorrhage, from rupture of the delicate capillary loops of maternal origin that surround the villi. Later, it is more frequently thrombosis in the sinuses, or the laceration of the delicate blood-vessels that perforate the upper layer of the decidua serotina to enter the placental sinuses.[3]

The consequences of placental hemorrhage to the fœtus depend upon the amount of blood extravasated. Should the quantity be large, either the number of villi strangulated by the clot is so great that the fœtus is at once asphyxiated, or else the escaping blood is able, especially in the earlier months, to strip the placenta off from the uterine wall, with the same result. The effect of placental hemorrhage upon the mother is usually unnoticeable, except in case the fœtus is killed, when the whole ovum will be prematurely expelled. In some instances, however, the blood will force itself between the placenta and uterus, and, burrowing its way downward through the layers of the deciduæ, will make its appearance externally as a hemorrhage from the uterus. Or else the blood, unable to escape, will collect at the placental site, or possibly over a larger area, sometimes in such quantities as to form distinctly an additional tumor of the uterus appreciable through the abdominal walls, and also to give rise to all the symptoms associated with serious loss of blood, these constituting those dangerous cases of concealed hemorrhage so often fatal in their results, unless the uterus be rapidly emptied of its contents that the organ may properly contract.

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[1] *Loc. cit.*

[2] *Arch. f. Gyn.*, 1873, Bd. v. S. 360.

[3] My friend Dr. Robt. H. Hamill of Philadelphia has recently shown me a specimen exhibiting what is, as far as my knowledge goes, a unique variety of placental hemorrhage. Immediately beneath the amnion there was a large clot occupying more than half the area of the placenta, and evidently containing all the blood of the fœtal body. The fœtus, corresponding in development to the fourth month, had bled to death into its own placenta from the rupture of a large branch of the umbilical vein due to some undiscoverable cause.

*Placentitis.*—An interstitial placentitis has already been described. Older authors paid particular attention to inflammations of the placenta, and Simpson described three stages of the disease—the first characterized by congestion, the second by plastic exudation, the third by suppuration. Numerous instances have been recorded in which "pus" was found in the placenta, but the majority of the cases reported will not stand modern investigation. There are, however, authentic instances of such an occurrence.[1]

*Cysts of the Placenta.*—Cystic formations may be found not very infrequently in the placenta. In the majority of cases they are the result of certain changes in extravasated blood. They are sometimes, however, to be ascribed to a circumscribed, unusually fluid myxoma.[2] Jacquet[3] has described small cysts springing from the blood-vessel walls.

*Tumors of the Placenta.*—The tumors that have been described by Clarke, Löbl, Marduel, and Hyrtl as fibromata and sarcoma of the placenta may be classed as myxomata fibrosa. Organized blood-clots have also been described as tumors of the placenta. Hecker[4] speaks of a fleshy substance expelled from the uterus post-partum, although the placenta had come away entire as possibly a placental tumor. This may, however, have been nothing but a uterine polypus or a piece of hypertrophied and angiomatous decidua serotina,[5] or a so-called polypoid hæmatoma of the placenta, placental polyp, or placental adenoma.

## THE UMBILICAL CORD.

The early development of the umbilical cord—or, in other words, the formation of the allantois—has been studied upon the lower animals, as

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[1] See Schroeder: *Lehrbuch*, ed. of 1884, p. 450.

[2] *Arch. f. Gyn.*, Bd. xi. S. 397.

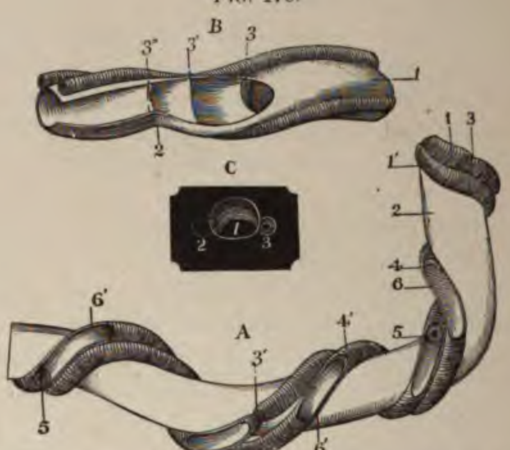
[3] *Gaz. méd. de Paris*, Oct. 14, 1871.

[4] *Klinik der Geburtsh.*, 1864.

[5] See paper by the writer in *Am. Journ. Obstet.*, Dec., 1887.

in all the human embryos observed the connection between the em
and the chorion was already established. Indeed, according to Hi
human embryo is from the first in connection with the periphery o
ovum. Very early, then, in embryonal life there may be observed a
like projection from the posterior end of the intestinal tract, whic
first solid, but later containing a canal, grows outward and backv
owing to the presence of the large umbilical vesicle anteriorly, un
comes in contact with the periphery of the ovum. Within this sau
shaped (αλλας, a sausage) projection are blood-vessels, which are ca
with its growth to the periphery of the ovum, where they enter the
of the chorion in the manner already described. Becoming reduc
two arteries and a vein within the allantois itself, they constitut
vessels of the umbilical cord, which are destined to carry the bloo
the fœtus to the placenta for aëration and nourishment, the two art
conveying dark venous blood, the vein returning bright oxyger
blood, resembling in this respect the pulmonary arteries and
Surrounding the blood-vessels of the cord is a peculiar gelati
substance, furnishing the vessels the most perfect protection pos
under the circumstances—the so-called gelatin of Wharton—der

FIG. 176.



A, umbilical arteries forming spirals (1, 1') around the vein; constrictions indicating th
ence of folds (3, 3'); circular folds (5, 5'); lateral openings showing the arterial wa
vein opened upon the side, showing a constriction (2) corresponding to an interio
(3''); semilunar valves (3, 3', 3''). C, section of vein and arteries, showing valve of v
a semilunar arterial valve (2), and a circular arterial valve (3) (Tarnier et Chantreuil

from the outer layers of the amnion and the allantois, both in
turn being derived from the median layer of the blastodermic
brane. As the amniotic cavity becomes distended, the amni
pushed out on all sides till it meets in front of the embryo and
rounds the cord like the finger of a glove, at the same time encl

the already atrophied umbilical vesical, the ductus omphalicus, and the pedicle of the allantois. That portion of the allantois that remains within the abdominal cavity forms the bladder and urachus. The umbilical cord at term measures about 20 inches in length and about ¼–½ an inch or more in diameter, this latter being irregular, from the fact that the arteries are coiled around the vein, usually from right to left, giving a twisted appearance to the cord, and also because the gelatin of Wharton is deposited irregularly, being in some places quite thick, and forming thus the so-called false knots of the cord.

Both the arteries and the veins of the cord have walls of almost the same thickness, and both are provided with semilunar valves. The calibre of the vein is greater than that of the arteries. According to Leopold,[1] it measures normally 2–4 mm. in diameter, but at a point about 8–10 cm. from the placental insertion there occurs a physiological narrowing.

ANOMALIES OF THE CORD.—The cord may be abnormally long, measuring rarely as much as 70 inches,[2] or may be naturally or artificially too short. The cord is artificially shortened in those adhesive inflammations of the amnion which may result in the gluing together of the coils or their attachment to the fœtal skin or amnion.

*Exaggerated Torsion.*—The cord may be so twisted upon its longitudinal axis that the vessels are nearly or quite obliterated, and the cord itself, especially near the umbilicus, is reduced to a very small diameter. Formerly the torsion was regarded as a cause of fœtal death, but Martin, Ruge, Schauta, and most modern observers regard the exaggerated torsion of the umbilical cord as a post-mortem occurrence, resulting from the great movability within the uterine cavity of a fœtus that has died during the fifth to the seventh month of pregnancy. The number of twists in the cord may be surprisingly great. In Schauta's[3] case it reached 380. Torsion occurs more frequently in male than in female children. Œdema and cystic degeneration may often be found in connection with exaggerated torsion.

*Stenosis of the Umbilical Vessels.*—The umbilical vein may be narrowed by the development in the intima of new connective tissue[4] to such an extent as to seriously impede the flow of blood from the placenta—a condition resulting in œdema of the latter organ, hydramnion, or an immense dilatation (to 15 mm.) of the undiseased portion of the vein, ending occasionally in its rupture (Leopold) and the extravasation of blood into the substance of the cord. This disease of the vein is usually attributed to syphilis. A periphlebitis may also

[1] *Arch. f. Gyn.*, Bd. viii. S. 221.

[2] Chantreuil: *Disposition du Cordon*, Paris, 1875.

[3] Leopold: *Arch. f. Gyn.*, Bd. xvii. S. 20; see also Winckel: *Berichte u. Studien.*

[4] *Neue Zeitschr. f. Geb.*, Bd. iv. S. 62; and Leopold, *loc. cit.*

occur, and may diminish somewhat, but not seriously, the calibre of the vein. The umbilical arteries are occasionally obstructed by atheroma and thrombosis.

The section of an umbilical cord taken from a syphilitic infant will sometimes show an enormous development of connective tissue throughout the entire wall of the arteries, so that it is impossible to distinguish the different coats; the lumen of the vessels is often obliterated, not only by the thickened walls, but by the infiltration of the whole substance of the cord with granulation-cells. Pinard[1] has seen the vessels of the cord obstructed by an over-development of the valves that are found in both arteries and veins.

*True Knots of the Umbilical Cord.*—Rarely, the fœtus slips through a loop of the cord, and, the two ends of the loop being then put upon the stretch, a true knot is tied. This process may be repeated either during pregnancy or while the child is descending in labor, and thus a double knot is tied. In the case of twins in a common amniotic cavity the most complicated knotting of the two cords may occur. The effect of these knots in the cord upon the circulation of the fœtus is usually not serious. Carl Braun[2] says that he has never seen the slightest disadvantage to the fœtus from this cause; but the knots can be drawn so tight as to completely shut off the placental blood-supply, especially in the case of twins in a single amniotic cavity, where one cord may be drawn in a tight knot about the other, obliterating the latter's blood-vessels. The gelatin of the cord is often displaced at the seat of the knot, so that when the latter is untied its situation is marked by deep depressions.

*Coiling of the Cord around the Fœtus.*—Loops of the cord may be wound about different portions of the fœtal body. The neck may be encircled once or twice, more rarely from four to nine times (Braun), or loops may be thrown around the limbs. The encircled part may be so compressed that it is strangulated and the distal portion is destroyed, but it is doubtful whether a constricting cord can ever determine the amputation of a part, for when it sinks through the soft tissues to the bones it there experiences a pressure greater than it itself can exert, and is therefore in its turn destroyed (Braun). Thus the neck has been severed to the spinal column, and limbs have been cut through to the bone, but there the process will usually stop.

*Marginal Insertion of the Cord.*—The cord is usually inserted somewhere near the centre of the placenta. As the insertion approaches the edge of that organ the condition receives the name of marginal insertion, or sometimes battledoor placenta. If the cord should first enter the membranes at some little distance from the placenta, to and from which the vessels, unprotected and more or less separated from one another, pursue their course between the amnion and chorion, a condition known as insertio velamentosa exists. The explanation of such an occurrence is obvious: The allantois is conveyed at first indifferently to any portion of the periphery of the ovum, but as the placenta begins to be differentiated the embryo, by a movement of rotation, enables the umbilical vessels to pursue a straight course toward their insertion in the placenta. Should the rotation of the fœtus be in any way interfered with, or should the newly-formed umbilical cord contract adhesions with the amnion or chorion that would prevent the vessels following or complying with the rotation of the embryo, they would naturally enter the membranes opposite the abdominal face of the embryo, or at that point where adhesions arrested their movements. The blood-vessels thus exposed are liable to laceration during labor, usually with a fatal result to the fœtus unless delivery is quickly effected.

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[1] *Dict. encyclopéd. des Sc. méd.*, art. "Fœtus."

[2] *Lehrbuch der Ges. Gynäk.*, p. 552.

*Umbilical Hernia.*—Occasionally children are born with a greater or less portion of the abdominal contents protruding into the umbilical cord, and covered by nothing but the distended and attenuated amnion. In such cases, if the opening in the abdominal walls is not too extensive, prompt surgical interference may effect a cure.

*Cysts of the Cord.*—Cystic formations in the cord are due either to an abnormally fluid condition of the mucous tissue or else to a collection of serum in the pedicle of the allantois, which in horses, swine, and cows is found persisting as a vesicle up to the time of birth.

*Calcareous Degeneration.*—This condition of the cord is occasionally found to a greater or less degree, usually associated with syphilis. The lime may be deposited in the walls of blood-vessels or in the substance of the cord.

## THE DECIDUÆ.

The explanation which John Hunter gave of the plates published by his brother William[1] was for a long time accepted as the true history of the development of the uterine membrane which envelops the fœtus at term. The Hunterian theory was that the uterus threw out upon its inner surface an inflammatory exudate, forming a closed sac whose walls stretched across the openings of the tubes and the os internum cervicis. As now the impregnated ovule entered the uterus from one of the tubes, it pushed the sac-wall in front of it, but left behind it a bare surface, which was soon, however, covered by an exudate similar to the one at first thrown out. That portion of the original membrane which remained attached to the uterine wall Hunter called the membrana vera; that portion pushed out in front of the ovule, membrana reflexa; and that membrane *last* formed behind the ovule, the membrana serotina. These names have survived till the present day, although modern investigation has robbed them of their original significance. Costi[1] was the first to expose the fallacy of the Hunterian doctrine, and since his time the investigations of Robin, Friedländer, Kundrat, Leopold, Engelmann, and others have enabled us to follow the changes that occur in the uterine mucous membrane from the entrance of the impregnated ovule into the uterine cavity until the fœtus, with its enveloping membranes, is expelled at term. By the time the fertilized ovum arrives within the uterine cavity the lining mucous membrane of the uterus has become very much thickened,[2] owing to a great increase in the interglandular connective tissue, which consists of enormously enlarged young connective-tissue cells, either closely pressed together or separated from one another by the cellular amorphous substance characteristic of newly-forming connective tissue. As a consequence of this thickening the mucous membrane is thrown into folds, and it is in a depression between two of these folds of membrane that the ovule falls and lodges as it first enters the uterine cavity. The ovule, being thus imbedded in the uterine mucous membrane, is gradually enclosed by the arching over of the folds of the membrane, or, as Leopold[3] claim by their simple approximation, owing to the increasing thickness the mucous membrane. That portion of the uterine mucous membra upon which the ovule rests, formerly called membrana decidua seroti

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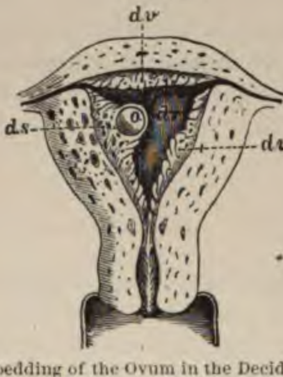
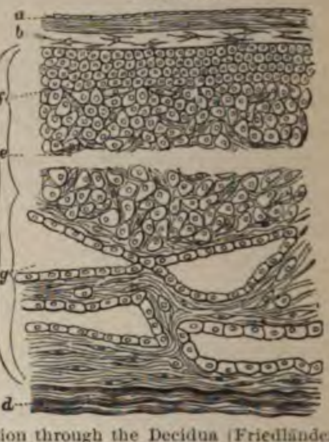
[1] *Anatomæ ut. hum. grav. tab. illustr.*, Birm., 1774, table 34.

FIG. 177.



Imbedding of the Ovum in the Decidua: *d. v*, decidua vera; *d. r*, decidua reflexa; *d. s*, decidua serotina; *o*, ovule (Schroeder).

FIG. 178.



Section through the Decidua (Friedländer): *a*, amnion; *b*, chorion; *c*, decidua; *d*, uterine muscle; *e*, line of separation in th cellular layer; *f*, cellular layer; *g*, glandular layer.

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[1] "Origine de la Caduque," *Acad. des Sciences*, Paris, 4 et 25 Juillet, 1842.

[2] Tenfold, according to Engelmann (*Am. Journ. Obstet.*, May, 1875).

[3] *Arch. f. Gyn.*, Bd. xi. S. 455.

is now more properly termed by the French the placental decidua, for it is upon this spot that the placenta will be developed; that portion of the membrane which arches over the ovule, called by Hunter the decidua reflexa, is better named the ovular or epichorial decidua; and that portion of the mucous membrane that remains as at first, attached to the uterine wall, the decidua vera of Hunter, is now more appropriately spoken of as the uterine decidua. The changes that occur in this last division of the uterine mucous membrane as pregnancy advances are, up to a certain point, only a continuation of the change already noted. The large cells already referred to, the decidual cells of Friedländer, multiply with great rapidity, and constitute a thick layer, the upper portion of the uterine decidua. The glands which at first send their ducts up through the cellular layer of decidua seem at last to be confined entirely to the deeper portions of the membrane, constituting, finally, what is known as the glandular layer. In its early stage of development the uterine decidua is richly supplied with blood; the capillary loops spring up luxuriously into the interglandular spaces; while deeper down, between the glandular layer and the uterine muscle, may be found numerous and extensive blood-sinuses. As, however, the ovular decidua comes in contact with the uterine layer, the blood-vessels are subjected to pressure and the stage of atrophy begins in the uterine decidua. The blood-vessels disappear, a fatty degeneration may be seen to begin in the cellular layer, no trace of epithelium remains in the superficial layer of the membrane, although epithelial cells persist in the glandular layer; and finally, as labor begins, the uterine decidua separates into two parts, the line of division running through the cellular layer, as is indicated in the drawing, while a part of the cell-layer and the whole of the glandular layer remain behind in the uterus to furnish the nucleus of a new mucous membrane which soon after labor takes the place of that which has been partly cast off. The history of the ovular decidua is one of atrophy almost from the beginning. As the growing ovum pushes out this portion of the uterine mucous membrane upon that pole of the sphere directly opposite the placental decidua, the epithelium of the membrane begins to disappear, and the blood-vessels are soon obliterated, so that at the end of the third month, when the ovular comes in contact with the uterine decidua, the former consists of not much more than a single layer of flattened and elongated cells. The development of the placental decidua has been described with the development of the placenta.

Diseases of the Deciduæ.—The decidual mucous membrane of the pregnant uterus may be the seat of any of the diseases that attack the endometrium of the non-gravid womb. In the former state, however, diseased conditions often manifest themselves in exaggerated forms, owing to the enormous hypertrophy that the mucous membrane of a pregnant uterus frequently exhibits. In consequence of its relation to the fœtus, too, a disease of the decidual endometrium can produce more serious effects than a similar affection of the uterus in a non-gravid state.

Diffuse Hyperplastic Inflammation of the Decidual Endometrium.—The atrophy of the deciduæ which normally occurs during the latter part of pregnancy may not take place, but in its stead the mucous membrane may go on to an increase of that hyperplasia which is a constant phenomenon in the earlier stages of its development. The cause of this over-development will usually be found in a pre-existing morbid condition of the endometrium, which predisposes it to respond with inordinate vigor to the stimulus which an impregnated ovule always furnishes the uterine mucous membrane to rapid growth and development. The pre-existing lesion is a chronic endometritis, either of ordinary type or of syphilitic or gonorrhœal origin. It may be possible, however, that the death of the embryo or some disease of the ovum may prove irritating enough to incite the mucous membrane of the uterus, previously healthy, to overgrowth. As the constituent parts of the mucous membrane are more or less affected, so will the manifestations of the disease vary.

*Diffuse Hyperplasia of the Decidual Endometrium.*—This condition of the mucous membrane consists in a simple progression of the hyperplasia that has been noticed as occurring normally in the early months of pregnancy, but which in these cases was, from the beginning, exaggerated. The steady increase in all the elements of the decidua with greater or less rapidity results in the production of a membrane of varying thickness and density, but always far in excess of the size of the normal deciduæ at term. Should the disease advance with great rapidity, an abortion will usually result, either on account of hemorrhages into the mucous membrane, separating it from the uterine wall, or owing to the death of the embryo, from which all nourishment has been diverted to supply the greater needs of the rapidly-growing decidua. In such cases the embryo may be absorbed, and the deciduæ afterward cast off as an empty sac with greatly thickened walls, forming one variety of the so-called fleshy moles.[1] Or the embryo may be destroyed in consequence of the hemorrhages into the hypertrophied decidua, the blood bursting its way through all the membranes and occupying the cavity of the ovum, as well as surrounding it exteriorly, so that only with a microscope can one detect the true nature of the mass expelled.[2]

On the other hand, if the development of the decidua goes on slowly and evenly, the fœtus may not be expelled before it becomes viable, or even until the normal end of pregnancy.[1] The structure of the hypertrophied decidua is usually only an exaggeration of what may be seen in the decidua of early pregnancy. There is a great multiplication of the decidual cells, some of which are elongated and seem to be transforming themselves into connective tissue; the blood-sinuses are much enlarged in the deeper portions of the membrane; and there is usually an abundance of connective tissue, or else, as Priestley describes it, an abundant exudation, which, at first simply amorphous or granular, soon becomes fatty, owing to the abundance of the exudate or its low vitality, which prevents the formation of the connective tissue that would otherwise develop from this plastic exudate. Madame Kaschewarowa[2] has described new-formed muscular fibres in an hypertrophied decidua, and occasionally either the cellular or the fibrous element has been found to greatly predominate.

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[1] Schroeder: *Lehrbuch.*

[2] Priestley: *loc. cit.*, p. 28, who quotes Gendrin, Hegar, and Westmacott.

The cause of hyperplastic decidual endometritis has been already referred to. The determining cause of the hemorrhages or "apoplexies of the ovum" so often destructive of the embryo and provocative of abortion in this affection, may be anything that would produce congestion of the pelvic viscera—physical exertion, full habit, or the recurrence of the menstrual period.

The effect of this disease upon the embryo or fœtus is, as may be imagined, usually disastrous; but upon the mother also the result of chronic endometritis decidualis may be injurious. The hemorrhages into the decidua may grow excessive in amount, but more frequently the maternal health is endangered by the retention of portions of decidua, varying in size, owing to adhesions between the diseased membrane and the uterine wall,[3] after the rest of the ovum is cast off. Especially is the placental decidua apt to surpass in its hyperplastic growth the remainder of the decidual membrane and to be retained in utero to give rise to hemorrhages, or by its decomposition to septicæmia. This is doubtless the condition described by Braun as placental polyp, and by Virchow, Winckel,[4] and others as polypoid hæmatomata of the uterus,[5] or by Klotz as placental adenoma.[6]

*Polypoid Endometritis.*—Instead of being evenly and generally thickened, the decidua may display at certain points a less-pronounced hypertrophy, or, on the other hand, upon the uterine surface may be

[1] I have seen a living fœtus, delivered at the sixth month, from a woman who three days afterward expelled a piece of decidua quite 1 cm. thick and measuring 5-6 cm. in diameter.

[2] *Virch. Arch.*, 1868, Bd. xliv. p. 103.

[3] This seems to be particularly true of syphilitic endometritis. See Kaltenbach, *Zeitschr. f. Geburt.*, Bd. ii. p. 225.

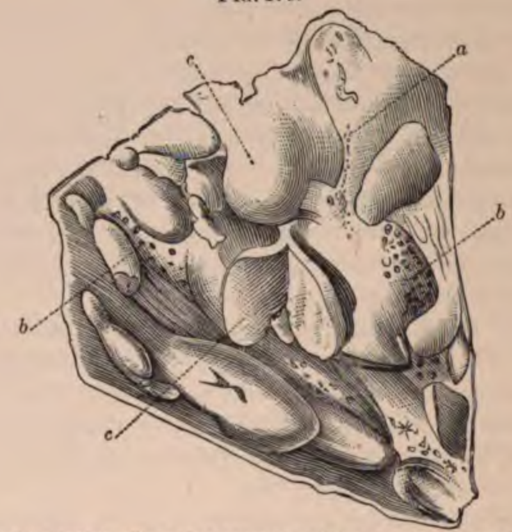
[4] *Path. u. Ther. des Wochenbettes*, p. 168.

[5] See paper by the writer in *Am. Journ. Obs.*, Nov., 1887.

[6] *Arch. f. Gyn.*, Bd. xxviii. H. 1.

seen projections or excrescences where the hyperplastic process seems to have been exaggerated over a limited area. Such cases have been described by Hofe[1] and Schroeder.[2] It is, however, to the most advanced type of this polypoid condition of the uterine mucous membrane that Virchow[3] first gave the name of endometritis decidua polyposa or tuberosa.

FIG. 179.



Polypoid Endometritis (Virchow): *a*, fine apertures of the glands; *b*, larger apertures of the glands; *c*, protuberances or polypi.

In these cases the internal surface of the decidua presents a most peculiar appearance. Villus-like projections stand out from the degenerated mucous membrane to the height of half an inch or more, smooth of surface and very vascular. In the intervals between the projections may be seen the openings of the uterine glands, which are not to be found on the polypoid elevations. The whole membrane is greatly thickened, which, as a microscopic examination shows, is due to the great hypertrophy of the connective-tissue elements and to a great increase in the decidual cells, which contain nuclei of enormous size. The connective tissue forms fibrous bands constricting the openings of the uterine glands, as well as the blood-vessels in the diseased membrane; and yet the whole decidua is exceedingly vascular. In Virchow's case there was a syphilitic history, and therefore this author ascribes the disease to syphilis; in other instances no cause whatever could be discovered; but often this disease, as well as other affections of the decidual endometrium, depends upon a pre-existing chronic endometritis. It is a disease of young ova, and frequently the chorion *villi* implanted in the diseased mucous membrane are in a condition of myxomatous degeneration.[1] In all the cases hitherto described the ovum has been expelled at the end of the second to the fourth month of pregnancy (Schroeder).

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[1] D. I., Marburg, 1869: *Ueber Hyperplasie der Decidua.*

[2] *Op. cit.*, p. 402.

[3] *Die Krankh. Geschw.*, Bd. ii. S. 478.

*Catarrhal Endometritis.*—A chronic inflammation of the decidual endometrium will occasionally affect chiefly the glandular elements of the membrane, with the result of a hypersecretion of a thin, watery mucus, which, collecting between the chorion and deciduæ, may be suddenly expelled, after a rupture of the ovular decidua, in the later months of pregnancy. This gives rise to sudden gushes of fluid from the vagina, which may occasionally reach a pint in quantity. Afterward the fluid may dribble away for a considerable length of time without affecting seriously the course of pregnancy, or else, collecting again in considerable quantities, it may excite the uterus to muscular action. This affection occurs more frequently in multiparæ than in primiparæ, and seems to depend in some cases upon a watery condition of the woman's blood. This condition is known as hydrorrhœa gravidarum. The escape of watery fluid occurs at intervals in gushes or constantly over a long period during pregnancy, and must be distinguished from a rupture of the membranes and the escape of amniotic fluid, which occurs but once and is soon followed by the expulsion of the uterine contents. Tarnier and Budin,[2] however, insist upon the occurrence of an amniotic hydrorrhœa characterized by the escape of amniotic fluid over a more or less extended period, and due to a rupture or perforation of the amnion at a point far removed from the eventual seat of rupture over the os internum. In support of this view these authors point to a specimen in the museum of the Maternité showing an aperture in the amnion remote from the point of rupture, round and regular as if cut out with a punch; and, moreover, they describe two cases that came under the clinical observation, the one of Ingleby, the other of Tarnier himself, in which apertures were found in the amnion far from the seat of rupture, and in which there had been an escape of fluid respectively three months and six days before the labor began. Erlich[3] has recently reported a case of interest in this connection in which the amnion was perforated by the sharp end of an ill-developed tibia that projected through the fœtal skin. This accident resulted in abortion.

*Cystic Endometritis.*—If there should be a hypersecretion of the uterine glands, and the escape of the fluid contained in the glandular spaces should be hindered, a condition results only found in very young ova, known as cystic endometritis. It is not improbable that this condition might be found pretty constantly in the earlier stages of the chronic hyperplastic decidual endometritis already described, the glands being destroyed and obliterated as the disease advances. A section of mucous membrane affected with cystic disease presents a somewhat cavernous appearance, numerous small cysts being scattered throughout its thickness. Their connection with the uterine glands can be demonstrated by the relation between the cysts and the ducts of the glands.[1] About the cysts the decidua is hypertrophied, presenting the over-development of connective tissue, increase of decidual cells, and embryonal tissue that has already been referred to.[2]

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[1] Müller, *Bau der Molen*, 1867.

[2] *Op. cit.*, p. 324.

[3] *Virch. Arch.*, Bd. c. p. 107.

As to the prognosis of all these chronic affections of the decidual endometrium, it is, as may be inferred, decidedly unfavorable for the fœtus and by no means entirely favorable for the mother. The danger to the fœtus from hemorrhages, which bring about separation of the membranes, or which, bursting through all the fœtal envelopes, overwhelm the embryo with blood, has been mentioned, as well as the diversion of nutriment from the embryo to the overgrown decidua, and the excitation of muscular action upon the part of the uterus which ends in the expulsion of the ovum. But the possible loss of blood during pregnancy, and the retention of fragments of decidua owing to adhesive inflammation, after the ovum is expelled, cannot be regarded with indifference as to their effect upon the mother.

The treatment of this condition during pregnancy is impossible. Its prevention may be attempted, however, by treating the chronic endometritis of ordinary or specific origin which almost invariably is the cause of the disease in the decidual membrane.

ACUTE INFLAMMATIONS OF THE DECIDUÆ.—It is in the course of cholera and other infectious, but especially the exanthematous, diseases, or in consequence of unsuccessful attempts to bring on abortion, or perhaps as a result of external injuries, that acute inflammation of the decidual membrane may be developed.

*Hemorrhagic Decidual Endometritis.*—This is the name given to that condition of the mucous membrane that Slavjansky[3] found in two cases associated with cholera. In these instances the decidua was thickened, of a dark purplish hue, and presented throughout its substance numerous extravasations of blood. It is not improbable that the same condition might be found in other acute febrile infectious diseases.

*Exanthematous Decidual Endometritis.*—Klotz,[4] in a very interesting study of the effect of measles upon pregnancy, presents the authentic history of 11 cases of this disease in pregnant women, in 9 of which there was a premature expulsion of the fœtus, the time at which the expulsive efforts began seeming to bear a certain relation to the outbreak of the eruption upon the skin. In these cases, according to Klotz, the uterine action is excited by the occurrence of an exanthema upon the uterine mucous membrane, highly irritating in its action, just as the photophobia, the coryza, the bronchitis, and the vesical tenesmus of measles indicate an irritated condition of the mucous membranes of the eyes, nose, lungs, and bladder. It is quite probable that the same condition of the uterine mucous membrane might account for the abortions or premature labors that often occur when pregnant women are attacked by any of the eruptive fevers.

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[1] Leopold: *Gesellsch. f. Geburtsh.*, Leipzic, Feb., 1878.

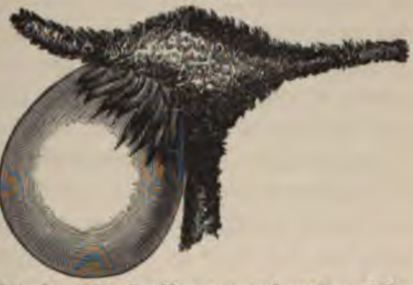
[2] See Breus: "Ueber cystöse Degeneration der Decidua vera," *Arch. f. Gyn.*, Bd. xix. S. 483.

[3] *Arch. f. Gyn.*, Bd. iv. S. 285.

[4] *Ibid.*, Bd. xxix. S. 448.

*Purulent Decidual Endometritis.*—Donat[1] has described a case of this nature. A woman expelled at term a placenta about the periphery of which could be seen masses of decidua infiltrated with pus. The amnion and chorion were both thickened and opaque, and between them was a collection of purulent fluid, which, according to Donat, must have broken its way from the deciduá through the chorion, and have collected between that membrane and the amnion. A most careful macroscopic and microscopic examination left no doubt whatever as to the nature of this case. It was suspected that the suppuration of the decidua was the result of unsuccessful attempts on the part of the woman to bring on a miscarriage. It has occurred to the writer, however, that pus might perhaps be pressed from a collection in a distended tube into a pregnant uterus, breaking its way through the ovular decidua in the latter part of pregnancy, or penetrating between the layers of the deciduæ in the earlier months, thus giving rise to a condition similar to that described by Donat. It is well known that quite a gush of pus may escape from a pyosalpinx into an unimpregnated womb, and there seems to be no reason to doubt the possibility of such an occurrence during pregnancy.

FIG. 180.



Atrophy of the Decidua, external surface of the vera (Duncan).

*Atrophy of the Deciduæ.*—The deciduæ, instead of undergoing inflammatory and hyperplastic changes, may, on the contrary, atrophy, although such an occurrence is doubtless rare. This change in the decidual membranes has been described by Hegar[2] and Matthews Duncan,[3] and among recent writers by Spiegelberg[4] and Priestley.[1] The uterine, ovular, or placental deciduæ may singly or conjointly be the seat of atrophy, resulting either in the ovum being attached by a mere pedicle of slender proportions to the uterine wall, or else, in the case of atrophy of the ovular decidua, the embryo lacks the outermost of its protective membranes, and consequently the ovum may rupture and its contents be discharged from the uterus. As a result of the stretching of the pedicle in cases of placental atrophy, the ovum may be pushed downward by the uterine contractions until it rests in great part within the cervical canal. This condition constitutes the cervical pregnancy of Rokitansky.

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[1] *Arch. f. Gyn.*, Bd. xxiv.

[2] *Monatsch. f. Geburtsh. u. Fr.*, Bd. xxi.; *Supplem.*, pp. 11, 19, 1863.

[3] *Researches in Obstetrics*, p. 295, 1868.

[4] *Lehrbuch*, p. 328.

## THE DISEASES OF THE FŒTUS.

The protection afforded the fœtus by its position within the uterine cavity, where it is apparently shielded from all unfavorable external influences, would seem, on first thought, designed to give the product of conception a complete immunity from many of the morbid processes which might afterward threaten its independent existence. But, bearing in mind the rapid and active growth which in a few months transforms a simple cell into the most complex being of all animal creation, and the ease with which the normal progress of this development might be disturbed; considering the fact that the most important vital functions are performed without the body of the fœtus in an organ subject to accidents and diseases; reflecting, moreover, that the fœtus is essentially a parasite, whose well-being is entirely dependent upon the health of its host,—it is little surprising to learn that the fœtal mortality exceeds that of any other period of life. It has been estimated that for every five labors (Parvin) there has occurred one abortion, and if to this number be added the stillbirths in which the death of the fœtus was not due to an accident in labor, the proportion of fœtal deaths to living births becomes very large. And in addition to the diseases having a fatal termination there are others affecting the fœtus in utero, running their course wholly or in part during intra-uterine life and ending in recovery; so that the category of fœtal diseases, whether affecting the fœtal organism alone or its appendages, or consisting in some disturbance of the maternal health which reacts injuriously or fatally upon the fœtus, is already an extensive one, and must in time become richer in the number and variety of diseases observed as the habit of recording interesting cases becomes more general, and the facility with which such records are collected from all quarters of the globe increases from year to year.

The study of the many morbid processes which can exert an unfavorable influence upon the growth and development, upon the health or the life, of the fœtus is of course surrounded with many difficulties; but it is not a study of purely theoretical interest, barren of practical results, for many of the affections which will come under consideration are susceptible of modification in their course or of a complete cure by a rational system of therapeusis. Those tendencies to disease, those constitutional vices, which, impressed upon the ovule at the moment of conception or acquired during intra-uterine life, only manifest themselves at some period more or less remote from birth, will not be considered in this place.[1] Nor will the diseases of the fœtal appendages, for they have been already described, so that the present section will treat of the diseases of the fœtal organism itself, of structural weaknesses dependent upon defects in the paternal elements entering into the composition of the embryo, along with certain conditions of the maternal organism which are incompatible with the healthy development or with the continued existence of the product of conception.

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[1] Op. cit.

## FŒTAL SYPHILIS.

First in importance, because foremost in frequency, protean in its manifestations, and most destructive in its action upon the development, the health, and the life of the fœtus (of all the diseases of intra-uterine life), fœtal syphilis deserves careful consideration. According to Ruge,[2] 83 per cent. of premature and still births have their cause in syphilis of one or both of the parents—a percentage which, large as it is, must be further increased to include the number of syphilitic children born alive, if one would estimate the relation that syphilis bears to the other diseases of intra-uterine life. The almost infinite variety in the manifestation of fœtal syphilis is perhaps more remarkable than the polymorphism of the disease acquired in adult life, and the fatality attending the affection in the fœtus may be learned from the statistics of abortion and premature labor in syphilitic women, or in cases where the disease is transmitted to the product of conception from the paternal parent alone. Of 657 pregnancies in syphilitic women collected by Charpentier,[3] 35 per cent. ended in abortion, and of the children that went to term a large number were stillborn.

*The Syphilitic Infection of the Fœtus.*—In the strict sense of the word the syphilitic infection of the fœtus is comparatively a rare occurrence. In the majority of cases, if the woman be syphilitic the ovule is already diseased before its impregnation; or the spermatic particle from a syphilitic man carries to the ovary of a healthy woman the poison of this disease; or, again, if both man and woman are diseased, all the more surely will the product of the union of an ovule and a spermatic particle, both syphilitic, display in a marked degree the signs of hereditary syphilis. Modern investigation tends to show, moreover, the possibility of infecting the healthy fœtus at any time during intra-uterine life should the mother acquire syphilis during pregnancy. This statement of the manner in which syphilis is inherited or transmitted may seem a trifle dogmatic in view of the fact that there is by no means a universal agreement upon the subject; but the evidence in favor of the views expressed is to the writer's mind quite convincing. No one, of course, now denies the fact that a woman infected before or at the time of impregnation will probably produce syphilitic offspring, but as to the possibility of the infection of the embryo by the father while the mother remains healthy there is still some difference of opinion. Collerier, Notta, Follin, Charnier, Mireur, Langlebert, Corry, Wolf,[1] and quite recently Schadeck,[2] have said that they do not believe that the infection of the fœtus is possible unless the mother is syphilitic; but of modern authorities, Tarnier,[3] Schroeder,[4] Charpentier,[5] Priestley,[6] and many others assert their positive belief that syphilis can be transmitted from a syphilitic father direct to the embryo without the previous infection of the mother. As the fœtus grows, however, and the syphilitic poison develops with its growth, the mother often becomes infected in her turn directly from the fœtus through the utero-placental circulation.[7] The longer the time since the acquisition of the disease by either parent, the less likelihood will there be of the production of syphilis in the embryo; but the limit of safety has not yet been discovered. According to Fournier,[8] four years is the maximum of time that syphilis can remain latent, but Lomer[9] tells of the production of a syphilitic infant ten years after the first infection of the father, and Kassowitz[10] records a latent syphilis of twelve years' duration.

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[1] See section on "Diseases of the Newborn Infant," Vol. II.

[2] See Lomer: *Zeitschr. f. Geburts.*, Bd. x. p. 189.

[3] *Traité pratique des Accouchements.*

In regard to the infection of the fœtus by syphilis acquired at some time during pregnancy by the mother, it has been said that "the syphilitic poison will not traverse the septa intervening between the fœtal and the maternal vascular systems;" but, on the other hand, Vajda[11] and Hutchinson[12] describe cases in which pregnant women were infected near term and gave birth to syphilitic children. Neumann[13] also has published his observations of 20 women who were infected with syphilis during pregnancy; 5 of this number gave birth to syphilitic children, and of these 5, 2 were infected at the fourth and 1 each at the third, seventh, and eighth months. But most strongly confirmative of this opinion of the transmissibility of syphilis from the mother to the fœtus during pregnancy are the observations of M. Hirigoyen[1] in the Maternity Hospital at Bordeaux: Of 12 cases in which the mother contracted syphilis during the first four months of pregnancy, all the children were stillborn; in those cases in which infection occurred from the fourth to the sixth month about half the children were stillborn; and in 7 cases of infection during the last three months of pregnancy there were 4 stillbirths.[2] Admitting, then, that a pregnant woman, having acquired syphilis, can transmit it to the fœtus in utero, it seems reasonable to admit also that the converse of this proposition must likewise be true: that a fœtus, infected by the syphilitic spermatic particle of its father, can convey the poison to its mother, in both cases the *materies morbi* passing through the delicate membrane that separates the fœtal from the maternal circulation. And this belief is strengthened by the fact that the investigations of Lustgarten,[3] Doutrelepont,[4] Chotzen,[5] and others tend to show that the specific poison of syphilis is "a particulate and living virus,"[6] for we know that certain pathogenic micro-organisms at least have the power of traversing the utero-placental septum.[7]

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[1] Tarnier et Budin, t. ii. p. 36.

[2] *St. Petersburg med. Wochenschr.*, 16, 17, 1886.

[3] *Loc. cit.*, p. 36.

[4] *Lehrbuch der Geburtshülfe*, 8th ed., 1884, p. 375.

[5] *Traité pratique des Accouchements.*

[6] "Pathol. of Intra-uterine Death," *Rep. of Br. Med. Journ.*, 1887.

[7] See Tarnier et Budin, *op. cit.;* Priestley, *loc. cit.;* J. Hutchinson, *Br. Med. Journ.*, Feb., 1886, p. 239; Harvey, *Fœtus in Utero*, 1886; G. S. West, *Am. Journ. Obstet.*, 1885, p. 182.

[8] *Syphilis et Mariage.*

[9] *Zeitschr. f. Geb.*, Bd. x. p. 94.

[10] *Stricker's Jahrb.*, 1875, p. 476.

[11] *Centralb. f. Gyn.*, 1880, p. 360

[12] *Br. Med. Journ.*, 1886, i. 239.

[13] *Wien. med. Presse*, 29, 30, 1885.

*Manifestations of Fœtal Syphilis.*—Syphilis having been acquired by the embryo at the moment of conception from pre-existing syphilis of the ovule or of the spermatic particle, or of both, or having been transmitted to the fœtus from the mother at any time during pregnancy, its manifestations during fœtal life can assume the greatest variety in the tissues attacked and the lesions produced. A description, however, of all the pathological processes traceable to syphilis which have been seen in aborted ova or in children prematurely born could be of interest only to the pathologist. It will be sufficient merely to mention the bullous eruptions of the skin, the condylomata and inflammations of the mucous membranes, the inflammations of the serous membranes, the gummatous and miliary deposits, and the morbid growth of connective tissues in the brain, lungs, pancreas, kidneys, liver, and spleen, the muscular system, and the coats of the intestines and walls of the blood-vessels, and a characteristic osteitis and osteo-chondritis. Some of these manifestations of fœtal syphilis, however, deserve more than a passing mention, for from their constant presence and characteristic features a diagnosis of the disease can almost invariably be made—a matter of considerable importance, as will be seen when we come to consider the habitual death of the fœtus in utero and its preventive treatment.[1]

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[1] Abstract in *N. Y. Med. Record*, April 12, 1887.

[2] The author has seen a woman, impregnated by a healthy man, but infected with syphilis in the third month of pregnancy, give birth to a child with a pemphigoid eruption upon it and a liver twice the normal size.

[3] *Die Syphilis Bacillen*, Vienna, 1885.

[4] *Jahrsehr. f. Dermatol. u. Syph.*, xiv. H. i. p. 101.

[5] *Ibid.*, p. 109.

[6] J. Hutchinson: *Br. Med. Journ.*, 1886, i. p. 279.

[7] Koubassoff: *Comp. rend. Acad. d. Sc.*, Paris, 1885, 101.

The influence of syphilis upon intra-uterine life is, as a rule, most deleterious if not fatal. If the fœtus is not destroyed before it has become viable, it is often born with signs of retarded development, performing in an imperfect manner its vital functions, or else exhibiting well-marked signs of disease in an enlarged abdomen due to ascites, to enlarged liver or spleen, with nodes in the lungs or in the bronchial glands, with hydrocephalus, separation of the epiphyses of the long bones from the diaphyses, with extensive pemphigoid eruptions on the skin, or perhaps presenting a deformed or monstrous appearance. There are cases, however, in which the course of intra-uterine life does not seem to be influenced in the slightest degree by syphilis. The children are born apparently healthy and well-developed, but exhibit well-marked signs of their hereditary taint within the first few weeks after birth.

*Treatment.*—The treatment of fœtal syphilis will be usually preventive, and must consist in an effort to improve the building material of which the future embryo will be constructed by eradicating the disease, by a thorough course of antisyphilitic treatment, from one or both parents. Should it be clear that the fœtus derives its syphilis from one parent alone, while the other remains healthy, then of course treatment of the healthy individual would be superfluous; but in case of the slightest doubt it would be prudent to administer to both man and woman the appropriate remedies.

Should a pregnant woman come under the observation of a physician with the history that she was with child by a syphilitic man, although healthy herself, or that she had acquired a chancre subsequent to conception, it would seem advisable to begin a course of mercurial treatment at once, not only with a view of improving the mother's condition, but with the reasonable hope of directly influencing the morbid processes that are possibly going on within the fœtus or its appendages; for, as Robolski[2] has shown that mercury administered in a soluble form to pregnant women may be found in the meconium and urine of their children immediately after birth, it is certain that the soluble salts of this drug will pass directly from the maternal into the fœtal circulation.

OTHER INFECTIOUS DISEASES OF THE FŒTUS.—As the infectious diseases are dependent upon the entrance of certain low forms of life into the system for the characteristic group of symptoms that distinguish the respective affections of this class, it is impossible that they should directly affect the fœtus in utero, unless pathogenic micro-organisms are able to pass from the maternal blood through the utero-placental septum into the fœtal portion of the placenta.

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[1] See the "Causes of Habitual Death of the Fœtus, and their Detection," p. 288.

[2] *Inaug. Dis.*, Halle, 1884.

But the views of competent observers as to the possibility of the passage of solid particles, no matter how minute, through the epithelial covering of the placental villi, stand at present diametrically opposed. On the one hand, the positive assertion is advanced, based upon experimental work, that the epithelial covering of the placenta offers an impermeable barrier to the passage of solid matter, while, on the other hand, one finds an equally positive declaration that the passage of such matter from the maternal circulation into the placenta has frequently been observed. Brauell[1] and Davaine,[2] experimenting with the bacillus of anthrax, saw large colonies of the micro-organism heaped up on the maternal side of the utero-placental septum, but failed absolutely to find a trace of them in the placenta or fœtus. Straus and Chamberland[3] failed to infect animals by injecting the blood of a fœtus taken from an animal that had died of anthrax. Runge of Dorpat inoculated a number of rabbits with tuberculosis, but failed absolutely to detect the characteristic bacillus in the fœtus. Chambrelent[4] quotes Budin, Tarnier, Charpentier, Hoffman, Jassinsky, and Fehling as denying the possibility of the passage of microbes from mother to fœtus. V. Ott,[5] in a recent article, after giving a résumé of the literature on the subject, expresses his disbelief in the passage of solid particles into the placenta, and supports his statement by describing experiments of his own which altered the constitution of the maternal blood without affecting that of the fœtus. Wolff[6] infected a number of pregnant rabbits and guinea-pigs with anthrax, and failed absolutely to find a trace of the disease in their young. Curt Jani,[7] an assistant of Prof. Weigert of Leipsic, having an opportunity to examine the body of a woman who had died in the fifth month of pregnancy from general miliary tuberculosis, found not a trace of the bacilli of tuberculosis in the placenta or fœtus, although every maternal organ was markedly affected. And Urvitch[8] inoculated seven pregnant mice with the microbes of mouse-septicæmia, which proving fatal to all of them, they were carefully examined, with the result of finding the specific micro-organisms in great quantities through the maternal tissues, but entirely absent in the placenta and fœtus. Inoculations with the blood of the mother-animals were invariably fatal to other mice, while the fœtal blood was entirely inert. Finally, Bompiani[1] delivered a woman who was suffering from anthrax, but whose fœtus showed no sign of the disease.

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[1] *Virch. Archiv*, xiv. 1858, p. 459.

[2] *Bullêtin de l'Academie de Méd.*, 1867.

[3] *Comptes rendus de la Société de Biologie*, 1882, p. 689.

[4] *Recherches sur le Passage des Éléments figurés à travers le Placenta*, Paris, 1883.

[5] *Arch. f. Gyn.*, Bd. xxvii.

[6] *Virch. Archiv*, 105, p. 192.

[7] *Ibid.*, 103, p. 522.

[8] *Inaug. Dissertat.*, St. Petersburg, 1885, p. 77.

But, on the other hand, not only microbes, but even small particles of colored substances like ultramarine blue and cinnabar, have been found in the placental and fœtal structures after they had been injected into the maternal tissues. In 1882, Arloing, Cornevin, and Thomas[2] showed the possibility of the passage of anthrax bacilli from mother to fœtus; and in the same year Straus and Chamberland, although they at first supported the views of Davaine and Brauell, finally changed their opinions and announced their belief in the transmissibility of contagious diseases to the fœtus in utero.[3] Chambrelent[4] also was able to cultivate the microbes of chicken cholera from the fœtal blood, and to reproduce the disease by inoculating an animal with the cultures. Mars[5] of Cracow found, after injecting putrid solutions into pregnant rabbits, not only in the maternal but also in the fœtal blood a great number of bacilli; and Dr. Pyle,[6] working in the pathological laboratory of the University of Pennsylvania under the superintendence of Dr. Formad, obtained practically the same results, not only in the lower animals, but, having an opportunity to examine the body of a human fœtus removed from its mother by Cæsarean section on account of her approaching death from septicæmia, he found vast numbers of micro-organisms in its blood. Finally, Koubassoff,[7] after experimenting under the supervision of Pasteur in his laboratory in Paris, claimed never to have failed to find the anthrax bacillus in the fœtus when the mother had been thoroughly infected with the disease, except in one instance, where of two fœtuses one was partially macerated and its placenta the seat of hemorrhagic extravasations, while the other was well developed. In the former of these two no bacilli were found, but in the latter they were present in large numbers. Upon this observation Koubassoff bases the conclusion that the placenta can only offer effective opposition to the passage of microbes when its condition is pathological. It seems difficult to come to a definite conclusion, in the face of such conflicting testimony, as to the passage of pathogenic micro-organisms from mother to fœtus; but, as there is no reason for doubting the positive assertion of those observers who declare that they have actually demonstrated the possibility of such a migration by finding certain microbes in the fœtus after they had been injected into the maternal tissues, and as the list of diseases which depend for their existence upon the presence of specific micro-organisms, and which have in certain well-authenticated cases undoubtedly attacked the fœtus in utero, is already a long one, it seems necessary to admit that while the presence of pathogenic microbes in the maternal organisms by no means assures their presence in the fœtus, yet the possibility of their migration across the utero-placental septum must be conceded.

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[1] *Annali di Ostet.*, May–June, 1887.

[2] *Comptes rendus des Séances de l'Academie des Sciences*, 1882, xcii. p. 739.

[3] See Koubassoff: *Ibid.*, vol. c. p. 373.

[4] *Recherches sur le Passage des Éléments figurés à travers le Placenta*, Paris, 1883.

[5] Abstract by Chambrelent: *Arch. de Tocol.*, 1883, p. 381.

[6] *Med. News*, Aug. 30, 1884.

[7] *Loc. cit.*

*Variola.*—The occurrence of variola during intra-uterine life has long been a fact beyond dispute, admitted even by the most zealous advocates of the theory that the placenta cannot be invaded by the germs of infectious diseases. Indeed, the fact that smallpox can attack the fœtus has been cited as an argument against the existence of a specific micro-organism for this disease. Very many cases are recorded in which a child marked with pustules was born of a mother who had been attacked with variola during pregnancy. But the susceptibility of the fœtus to the disease varies in a remarkable manner. No doubt, as Tarnier[1] says, in the majority of cases the fœtus manifests no signs of the disease even though the mother be seriously affected, but the mother may have only varioloid and yet the child be born with the marks of smallpox on it;[2] or, still more remarkable, the mother, having been exposed to the contagion of smallpox, but having shown no sign of the disease, may give birth to a child covered with pustules.[3] Again, it has been noted that, of twins, one or both of the children may be affected.[4] The fact that smallpox can attack the fœtus has led many observers to test the possibility of an intra-uterine vaccination, with the result that *a priori* might have been predicted. While in the majority of cases the attempt to give the fœtus an immunity against an attack of smallpox after birth by vaccinating the pregnant woman has been a failure, in a few instances it has been successful. For example, Behm[5] vaccinated 33 women, and of their children, 25 were successfully vaccinated after birth. Wolff[6] says that he has repeatedly vaccinated pregnant women, and has never failed to successfully vaccinate their offspring. Ridgen[7] tells of 8 cases of smallpox occurring in pregnant women in whose children, born alive, a subsequent vaccination "took." On the other hand, Desnos[8] and Chambrelent[9] each relate a case in which vaccination was several times unsuccessfully performed upon children whose mothers had shortly before their delivery recovered from an attack of smallpox. Chambrelent, moreover, vaccinated 7 pregnant women, but of their children he was able to successfully vaccinate only 3. Precisely, therefore, as smallpox can affect the fœtus in utero, but does not, as a rule, so can the fœtus in utero in exceptional cases acquire an immunity from smallpox by the vaccination of its mother—an occurrence, however, of such uncertainty as not to justify the neglect to vaccinate also the newborn infant.

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[1] Tarnier et Budin: *Traité des Accouch.*, vol. ii. p. 14.

[2] Charcot: *Comptes rendus de la Société de Biologie*, 1851, p. 39, and 1853, p. 88; Chaigneau: *Thèse de Paris*, 1847; Chantreuil: *Gaz. des Hôpitaux*, 1870.

[3] Laurent: *Lyon Médicale*, 1884, June 15.

[4] *Obstet. Trans. London*, vol. iii. p. 173.

[5] *Zeitschr. f. Geburt.*, Bd. vii. p. 1.

[6] *Virch. Arch.*, Bd. cv. p. 192.

[7] *Br. Med. Journ.*, 1877, i. p. 229.

[8] *Société méd. des Hôpitaux*, 1871 (see Tarnier et Budin, *op. cit.*, p. 13).

[9] *Loc. cit.*, p. 385.

*Measles.*—The transmission of the poison of measles from the mother to the fœtus is undoubtedly a rare occurrence, but there are, nevertheless, certain well-authenticated cases on record of children born with a rubeolous rash upon them: Thomas[1] was able to collect 6 such cases from medical literature. There are also cases recorded of measles appearing in the first few days of extra-uterine life, making it probable, from the short period of incubation, that infection had occurred in utero.

*Scarlatina.*—More than one eminent authority has expressed a doubt as to the occurrence of scarlet fever in utero, but the evidence, although scanty, is conclusive that on rare occasions children have been born with a well-marked scarlatinous rash upon them. Dr. Leale[2] of New York describes a case in his own practice in which a boy was born at the beginning of a well-marked attack of scarlet fever in the mother which she had contracted from an older child. The newborn infant presented a dark, congested red hue and a characteristic raspberry tongue. The eruption lasted seven days, and desquamation began on the tenth day, at which time the albuminous urine and general anasarca pointed to a desquamative nephritis. This child recovered. Dr. Leale was, moreover, able to collect a number of cases recorded by Hüter, Meynet, Asmus, Baillou, Tourtual, Gregory, and Stichel. Dr. Wilson Saffin[3] of Carthage, Ohio, has also reported a very interesting case of scarlet fever in utero: A lady who had had scarlet fever in childhood was nursing her child through the disease while she herself was in the last month of pregnancy. She was not affected by the disease, but complained of a bad sore throat. Two weeks afterward she was delivered of a male child with a typical scarlet rash upon it; the disease ran a course of nine days, with desquamation in large and small flakes, beginning on the fifth day. The infant's temperature ranged from 100°–104° Fahr., and the attack ended in recovery. In this case the mother, without contracting scarlet fever herself, had nevertheless transmitted the disease to her child in utero.

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[1] *Ziemssen's Handbook*, vol. ii. p. 50 (see also Underhill, *Obstet. Journ. Great Britain and Ireland*, 1880, p. 385, and MacDonald, *Edin. Med. Journ.*, 1884–85, 699).

[2] *Medical News*, 1884, p. 636.

[3] *N. Y. Med. Record*, April 24, 1886.

*Erysipelas.*—Kaltenbach[1] in 1884 observed a child, born of a woman who had had erysipelas in the last month of pregnancy, that a few days after birth shed its skin as if it had had an attack of erysipelas in utero. Runge[2] of Dorpat and Stratz[3] have described similar cases, but Tarnier[4] calls attention to the fact that desquamation in the healthy new-born infant is not such an uncommon occurrence. Lebedeff,[5] however, has presented convincing evidence as to the possibility of intra-uterine erysipelas in the following case: The child of a woman delivered at the seventh month in the midst of an attack of erysipelas presented alternate patches of red and white on its skin at birth; it lived ten minutes: after death Fehleisen's micrococcus was found in the subcutaneous adipose tissue, was cultivated, and rabbits inoculated with the cultures acquired the disease. No microbes, however, were found in the placenta or cord. Lebedeff believes that the specific microbes entered the placenta through a villus deprived of epithelium (Langhans).

*Malaria.*—The same difference of opinion that is met with as to the existence of many other diseases of the fœtus in utero is encountered in the study of congenital malaria. Among others, Burdel[6] expresses his disbelief in the existence of congenital malaria, and Tarnier quotes Leroux as saying that "as yet it is impossible to say positively that congenital malaria exists;"[7] but the testimony as to the occurrence of symptoms of disturbance in the unborn fœtus at regular intervals corresponding or not to the attacks in the mother, and the manifestations of periodical seizures beginning immediately after birth, is quite voluminous and of a credible character. Behrmann relates[8] two cases of intra-uterine infection in which the disease manifested itself directly after birth. Dr. W. T. Taylor of Philadelphia presented to the Philadelphia Obstetrical Society the history of a lady who, having lived during the last months in a malarial locality, moved to a healthy situation to be delivered. The nurse noticed that the newborn child was seized with attacks of restlessness during the first week of extra-uterine life, and evident discomfort at a certain period during the day. As a malarial origin of the attacks was suspected, quinine was administered to the mother, and in a short time the infant became healthy. Dr. Harris at the same time described a similar case yielding to the same treatment.

Aside, however, from the direct action of the malarial poison upon the fœtus in utero, the existence of malaria in the mother seems to have a deleterious influence on its growth and development. Thus,

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[1] *Centralb. f. Gyn.*, No. 44, 1884.

[2] *Centralb. f. Gyn.*, No. 48, 1884.

[3] *Centralb. f. Gyn.*, ix. 213.

[4] *Loc. cit.*

[5] *Zeitschr. f. Geburt.*, xii. 2, p. 321.

[6] *Annales de Gyn.*, viii. p. 31.

[7] *Op. cit.*, p. 24.

[8] *Berlin. klin. Wochenschr.*, 1885, Aug. 24, Sept. 7.

Bompiani[1] says that the children born of malarial mothers very rarely reach 3250 gm. in weight or 50 cm. in length, and Negri[2] observed 34 cases in pregnant women, of which 18 per cent. terminated by premature expulsion of the fœtus, which was in two instances macerated. The administration of quinine in large doses to the mother affected with malaria would therefore be called for, and one need not be deterred from employing the drug by the fear that once prevailed of so bringing on an abortion, for, as Tarnier says, "quinine, in this condition, is the best prophylactic treatment against abortion or premature labor."

*Tuberculosis.*—Considering the very large number of tuberculous women who become pregnant, it is an extraordinary fact that the direct transmission of the disease from the mother to the fœtus is an extremely rare occurrence. Runge[3] of Dorpat infected a number of pregnant guinea-pigs with tuberculosis, but invariably failed to find the characteristic bacilli in the fœtal tissues or placenta. Ballinger, Davaine, Brauell, and Wolff have all expressed a decided disbelief in the existence of congenital tuberculosis, and Jani's observations have already been referred to. But Demme once found the tubercle bacillus in the macerated fœtus of a tuberculous woman, and on one occasion Johne[4] discovered tubercles in a stillborn calf, in which he found the bacillus tuberculosis. While, therefore, there is a remote possibility of the passage of tubercle bacilli from mother to fœtus, it must be regarded as a very exceptional occurrence.

*Septicæmia.*—The possibility of the transmission of septic microorganisms from mother to fœtus has been denied by many, but the occurrence of septic infection of the fœtus in utero has been strongly affirmed by Koubassoff, Chambrelent, Pyle, Mars, H. v. Holst, and others. Mars[5] of Cracow injected putrid solutions into pregnant animals, and found often the same bacilli in mother and fœtus. Dr. Pyle's observation on the body of a fœtus removed by Cæsarean section from its mother, who was dying of septicæmia, has already been noticed; and, finally, Von Holst,[6] after an extensive search through medical literature, asserts positively that, although intra-uterine septic infection of the fœtus is rare, it has undoubtedly occurred.

*Cholera.*—Tarnier[7] says that there is nothing to justify the belief that cholera affects directly the fœtus in utero; and Queirel[8] asserts that it is doubtful whether cholera can be conveyed to the fœtus in utero, but, nevertheless, early abortion is the rule, and if the child should be born near or at term it dies in a few days.

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[1] *Annal. di Ostet.*, vi. 42, 46, 1884.

[2] *Ibid.*, viii. p. 277.

[3] Quoted by v. Ott, *loc. cit.*

[4] Quoted by Wolff, *loc. cit.*

[5] *Abstract Arch. de Tocol.*, 1883, p. 380.

[6] *Dissertation*, Dorpat, 1884; *Abstract Centralb. f. Gyn.*, 1885, p. 200.

[7] *Loc. cit.*

[8] *Nouv. Arch. d'Obstét. et de Gynéc.*, April 25, 1887, p. 1.

*Typhoid Fever.*—The effect upon the fœtus of typhoid fever in the mother is, as a rule, disastrous, resulting in the expulsion of the product of conception in about 65 per cent. of the cases,[1] "the elevation of the temperature, the alteration of the blood, and the respiratory embarrassment" (Tarnier) being considered the causes of the abortion or premature labor. But that the disease can affect the fœtus itself has been shown by Neuhaus,[2] who found Ebert's rods, the specific bacilli of typhoid fever, in the lungs, spleen, and kidneys of a fœtus expelled at the fourth month from a woman who was convalescing after a prolonged attack of typhoid fever.

*Articular Rheumatism.*—The consideration of this disease among the infectious diseases is perhaps not yet entirely justifiable. There are, however, two instances on record of the transmission of the disease from mother to fœtus—one described by Pocock,[3] the other by Schaeffer.[4] In each a woman affected with articular rheumatism at the end of pregnancy gave birth to a child presenting in one case at once, in the other at the end of three days, unmistakable evidence of being affected with the same disease.

*Recurrent Fever.*—Albrecht[5] has described three cases of congenital recurrent fever, and in the blood of one fœtus he discovered the spirilla.

*Yellow Fever.*—Dr. Bemiss[6] of New Orleans says: "The pregnant woman being attacked by yellow fever and recovering without miscarriage, immunity from future attacks is conferred upon the offspring contained in the womb during the attack." If this is true, it certainly seems that the fœtus must have likewise passed through an attack of the disease.

Summarizing, now, the evidence in regard to the passage of pathogenic micro-organisms from mother to fœtus, and finding so many well-authenticated cases of fœtal infection by diseases depending upon a specific living virus for their characteristic manifestations, it seems necessary to admit the possibility of a migration of such microbes from the maternal blood into the placenta. But, at the same time, it must be conceded that such an occurrence is rather exceptional, and that it is impossible to admit the truth of Koubassoff's dictum, that a failure on the part of the microbes to pass the utero-placental septum indicates a pathological condition of the placenta. Whether, on the other hand, Lebedeff's theory is true, that it is only possible for microbes to enter the placenta through a villus that is deprived of its epithelial covering, must as yet remain in doubt.

NON-INFECTIOUS DISEASES OF THE FŒTUS.—The diseases that have been considered have their origin in the maternal organism, and in each instance a specific *materies morbi* is transmitted to the fœtus; but there is another class of morbid processes having an independent origin in the fœtus itself, and not directly dependent upon a pre-existing disease of a like nature in the mother, although no doubt the predisposing, and even the exciting, causes are often to be found in the malnutritive condition of the maternal blood or in some morbid nervous action. So close occasionally is the apparent connection between a disease of the mother and a similar affection of the fœtus that the belief in the transmission from one to the other seems at first unavoidable. So, for instance, in that interesting case described by Dohrn[1] of a mother affected in the last weeks of pregnancy with purpura hæmorrhagica giving birth to a child presenting numberless subcutaneous hemorrhagic extravasations, the fœtal disease seemed to be directly derived from the maternal affection. Here, however, the woman being miserably poor and badly nourished, and her blood consequently being insufficient in nutritive qualities, the same cause naturally produced the disease in mother and child. So, again, in the following case, related by Strachan,[2] the disease might at first seem to have been transmitted from mother to fœtus: A woman in the eighth month of pregnancy was admitted to a hospital ward on account of acute pneumonia of the left lung. Shortly afterward she gave birth to a child that lived only a few hours, and which after death was found to have also acute pneumonic consolidation of the left lung.[3] But the ingenious explanation of Geyl,[4] who has observed several undoubted cases of acute pneumonia in utero, is no doubt correct. In these cases there has been some interference with the oxygenation of the fœtal blood, and the resulting asphyxia has induced efforts at respiration, whereby amniotic fluid has been drawn into the lungs and there set up an inflammation.

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[1] Duguyot: *Thèse de Paris*, 1879.

[2] *Berlin. klin. Wochenschr.*, 1886, p. 389.

[3] *London Lancet*, 1882, ii. p. 804.

[4] *Berlin. klin. Wochenschr.*, 1886, S. 79.

[5] *St. Petersburg med. Woch.*, 1880, No. 18, u. 1884, p. 129.

[6] See Parvin's *Obstetrics*, p. 222.

Notwithstanding our very scanty knowledge of the pathology of intra-uterine life, the list of diseases which are at present under consideration is already an astonishingly long one. They may be said in some instances to owe their origin to a vitiated condition of the maternal blood, or to be due to inherent weakness in the building material of the fœtus, as in cases of chronic systemic affections of either parent, or to be caused by perverted nervous action in the mother; while there are still others for which a cause is unassignable. Some of these affections may be passed by with a simple mention. Such are inflammations of the serous membranes,[5] and the resulting ascites, hydrothorax, hydrocephalus, due in the majority of cases to syphilis, although there is one case[1] on record of atresia vulvæ et recti and a vesico-uterine and utero-rectal fistula, where the urine escaped into the peritoneal cavity through the Fallopian tubes and set up a violent peritonitis; certain skin diseases, as ichthyosis, alopecia, hypertrichosis, albinism, purpura hæmorrhagica, and elephantiasis;[2] intra-uterine brain disease,[3] which may consist in sclerosis, atrophy, lack of development, tumors, cysts, or inflammation of the membranes, diseases of the liver, sclerotic or multicystic,[4] along with cystic disease or cirrhosis of the kidneys and the many varieties of congenital tumors, solid or cystic, malignant or benign, which are better described in text-books on pathology or surgery, or in connection with the study of dystocia. In addition to these affections, however, that have been so hastily passed over, there are others deserving more consideration.

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[1] *Arch. f. Gynäk.*, Bd. vi. S. 486.

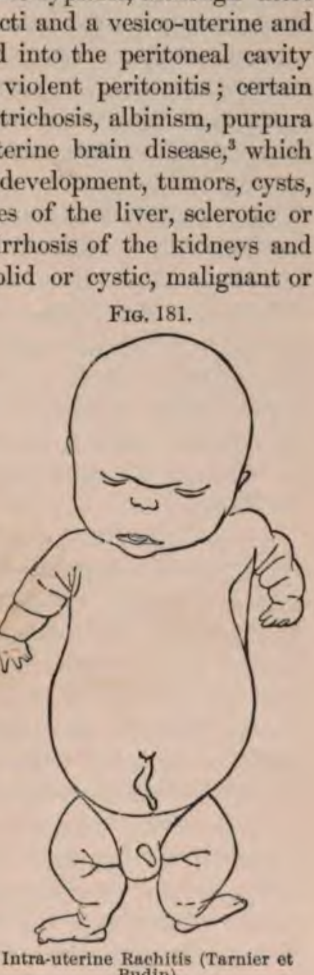
[2] *Br. Med. Journ.*, 1886, ii. p. 860.

[3] The author has reported a case of pneumonia in utero in the *Am. Journ. Obstet.*, Nov., 1887 (Tr. Philada. Obstet. Soc.).

[4] *Arch. für Gynäk.*, Bd. xv. 384.

[5] For a reference to endo- and pericarditis see Cruveilhier, quoted in *Ann. di*

FIG. 181.



Intra-uterine Rachitis (Tarnier et Budin).

*Rachitis.*—That this disease affects the fœtus in utero there is the most abundant evidence. Children have been born with the rachitic processes in their most active stage; that is, while the bones are still soft and easily distortable, or at birth, the process has evidently pursued a longer course, for the bones are abnormally hard and thick, and set in the deformed shapes that they have acquired in utero.

Schorlau[5] collected the records of 43 cases of congenital rachitis, and added to the number 2 of his own; while Gräfe[6] mentions the cases that have been described by Sandefort, Winckler, Schultz, Virchow, Kehm, and Fischer; and of late years Fehling[7] and Hennig[8] have also described specimens of fœtal rachitis.

As the etiology of infantile rachitis is by no means clear, it is all the more difficult to explain the occurrence of rachitis in utero. It may be said, however, to depend upon some vice of nutrition, especially if the

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*Obstet.*, July, Aug., 1887, p. 314; and for congenital valvular defect, diagnosticated before birth, see *Tr. Med. and Chir. Fac. Maryland*, 1884.

[1] Olshausen: *Arch. f. Gynäk.*, Bd. ii. S. 280.

[2] Duhring: *Diseases of the Skin*, p. 418.

[3] *London Lancet*, 1886, i. p. 220.

[4] *Tr. London Path. Soc.*, vol. vii. pp. 229, 235.

[5] *Monatschr. f. Geburtsh.*, Bd. xxx. S. 401.

[6] *Arch. f. Gyn.*, Bd. viii. S. 500.

[7] *Ibid.*, Bd. x.

[8] *Transactions of Meeting of German Naturalists and Physicians*, Berlin, 1886.

pregnant woman is living under unfavorable conditions as to food, light, and ventilation; but the fact that the mother has at some time had rachitis herself, as evidenced by the shape of her pelvis, seems of itself by no means to predispose the fœtus to the same affection. The appearance of a rachitic fœtus, especially in the higher grades of the disease, is quite distinctive. Such a fœtus will show an enlarged head, perhaps hydrocephalic, gaping sutures and fontanelles, a "pigeon" breast, a much-distended abdomen, the extremities short, thick, and often bent at an angle or curved, and the joints large and prominent. The spine will often be curved either laterally or antero-posteriorly.[1] The bones will be either abnormally hard and firm, or, on the other hand, the medullary spaces of the long bones may so encroach upon the hard bony tissue as to be covered with a very thin layer of bone, which will be fractured by the use of the slightest force. This condition of the bones in rachitis may be simulated by the arrest of bony development in those cases of fœtal cretinism[2] occasionally met with in Europe.

*Anasarca.*—General anasarca of the fœtus, occurring perhaps in conjunction with anasarca of the mother, but more frequently associated with no apparent maternal affection, is occasionally seen. The distension of the fœtal skin may reach such dimensions that the expulsion of the child becomes exceedingly difficult.[3] Such children are, however, usually born prematurely from the fourth to the eighth month, and are, as a rule, stillborn, although cases are recorded in which death only occurred some little time after birth. The causes of this condition must be various. It has been attributed to anasarca of the mother, to syphilis—in one instance to leukæmia of the fœtus,[4] in another to obstruction of the umbilical vein;[5] and Steinwirke[6] describes a case under the name of elephantiasis congenita cystica. The serous infiltration of the skin is usually accompanied by a collection of fluid in the abdominal and pleural cavities, and the membranes and placenta are often markedly œdematous.

*Spontaneous Fractures in Utero.*—The fœtal bones may be broken by external violence, or a child may be born presenting numerous fractures, especially of the long bones, either recent or already undergoing repair, without the history of an accident of any kind to the mother during pregnancy. If in such cases one can exclude a syphilitic osteo-chondritis with a separation of the epiphysis and diaphysis, or an injury to the child during labor, there must have been a rachitic condition of the bones or an arrest of ossification to allow of fracture by the slight force which could be exerted by the fœtal muscles or the pressure of the uterine walls. Link,[1] however, describes a case of numerous fractures in utero of the ribs, clavicle, and extremities in which syphilis, rachitis, and chronic parenchymatous osteitis could be excluded, and he therefore concludes that these fractures were caused by an "unknown intra-uterine fœtal bone disease," in which the bones became soft and brittle.

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[1] Gräfe, *loc. cit.*

[2] *Virchow's Arch.*, Bd. c. S. 256.

[3] Keiller: *Edinb. Med. and Surg. Journ.*, April, 1855.

[4] Klebs: *Prag. med. Wochenschr.*, 1878, No. 49.

[5] *Breslauer Klin.*, Bd. i. S. 260.

[6] *Dissertat.*, Halle, 1872.

*Luxations and Ankyloses.*—These affections of the joints are interesting—the first to the surgeon, the second in connection with the study of dystocia. It is interesting to note that luxations affect females four times as often as males,[2] and are much more common in the lower than in the upper extremities. An apparent ankylosis[3] after birth occasionally appears when in breech presentations the presenting part has remained a long time in the cavity of the pelvis. In these children the lower limbs remain in the position—of flexion of thighs upon abdomen and extension of legs upon the thighs—that they occupied in utero, and it is impossible for a while to restore them to a proper position.[4]

*Intestinal Invagination.*—Lauro[5] has very recently described a double invagination of the descending colon during intra-uterine life.

*Intra-uterine Amputations.*—The complete severance of a portion of a limb from its connection with the body of the fœtus in utero is an extremely rare occurrence, but one which has been often enough described—in many instances no doubt in mistake for some form of ectromelic monstrosity. There are, however, at present a number of undoubted cases on record.[6] The explanation of this affection is most frequently to be sought in the presence of constricting amniotic bands—a condition more fully discussed under the pathology of the amnion—but this explanation will not suffice for all cases; for it has been demonstrated that a gangrenous process[7] at a certain point in the limb may determine an amputation, just as it would in extra-uterine life, or that a peculiar morbid process[8] may produce a constriction from the circular contraction of connective tissue at a certain point, or, again, that an amputation[9] may follow a fracture. The amputated part may float loose in the amniotic liquid, may possibly be absorbed if detached early in embryonal life, or may be attached to the sound portion of the limb by a filament more or less bony (Tarnier et Budin).

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[1] *Archiv für Gynäk.*, Bd. xxx. 2, p. 264, 1887.

[2] Tarnier et Budin: *loc. cit.*

[3] Lefour: *Presentation du Siège décomplète Mode des Fesses*, Paris, 1882.

[4] The fixation of the limbs or trunk in abnormal positions by muscular contraction may occur in utero during pregnancy, as in that interesting case of "contracture" in utero (Ribemont-Dessaigne, abstract in *Nouv. Archiv. d'Obstét.*, Sept., 1887). In this connection the student should consult also the paper by Matthews Duncan on "Extensions and Retroflexions of the Fœtus, especially of the Trunk, during Pregnancy" (*Trans. London Obstet. Soc.*, xxvi., 1884, p. 206).

[5] *Annali di Ostet. e Ginecol.*, Luglio-Agosto, 1887.

[6] For an extensive bibliography see Tarnier et Budin.

[7] Chaussier: *Procès verbal de la Distribution des Prixes à la Maternité*, 1822.

[8] Kristeller: *Monatsch. f. Geburt.*, Bd. xiv. p. 817.

[9] Martin: *Gaz. hébdom.*, 1858, p. 384.

## FŒTAL TRAUMATISM.

The position of the fœtus in utero is one that secures it the greatest possible immunity from external violence, surrounded as it is by liquid, protected by the soft and flexible uterine muscles, and further shielded by the fatty, muscular, and cutaneous tissues that form the abdominal walls; but, in spite of this evident attempt of Nature to afford it every protection, the fœtus can experience injuries of the gravest nature, either in connection with serious injury to the mother, or occasionally with very slight evidences of violence to the maternal tissues. Thus in cases of gunshot,[1] stab,[2] or other perforating wounds of the abdomen in pregnant women, the fœtus has likewise been severely and fatally wounded. Also, in the performance of laparotomy[3] by a mistaken diagnosis the trocar that was plunged into what was thought to be an ovarian cyst has penetrated the fœtus, and wounds have been inflicted by both sharp and dull instruments ignorantly used to bring on an abortion or in the hands of physicians who overlooked the condition of pregnancy (Tarnier et Budin). On the other hand, as instances of fatal injury to the fœtus without apparent injury, externally at least, to the mother, might be cited those interesting cases of Mascka[4] and Gurlt,[5] in which the cranial bones of the fœtus were fractured by the mother falling from a height, or the still more remarkable case described by G. von Hoffmann[6] of a woman in the fifth month of pregnancy who threw herself out of a fourth-story window, and was killed by the fall, although she exhibited no signs of external injury: the uterus was uninjured, and the fœtus externally was apparently unharmed, but on opening its abdomen the liver was found to be almost disintegrated. The case, however, reported by Dr. Lumney[7] shows more clearly how a slight violence to the mother may be fatal to the fœtus: A pregnant woman, within ten days of term, attempting to enter a doorway, slipped and struck the left lower portion of her abdomen against the edge of the door. The movements of the child thereupon ceased, and eight days afterward a dead fœtus was born with a fracture of the left frontal and parietal bones of the skull.

These cases of fœtal injury are not only interesting from their rarity but they are also important from a medico-legal point of view. Thus, Gorhan[1] records the death of a fœtus from violence done the mother at the hands of another woman in the course of a brutal quarrel between two sisters-in-law, during which the pregnant woman, being at the time in the sixth month of gestation, was thrown to the ground and stamped upon by her infuriated relative. Two months afterward a dead fœtus was born, corresponding in development to the sixth month of pregnancy, and exhibiting a transverse fracture of both parietal bones. It might also be of great importance to distinguish injuries experienced during labor, as fractures of the extremities, spine,[2] or skull (löffel-[3] oder rinnen förmiger Eindruck), from the effects of traumatism during pregnancy, as well as from the spontaneous fractures of bones in utero. There should be no difficulty in making the distinction—on the one hand, by the history, and, on the other, by the multiple nature, of the apparent injury which is usually found in spontaneous fractures and by the evidence of disease in the bones.

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[1] Hays: *Ann. de Gyn.*, 1880, xiii. p. 153.

[2] Fennell: *Tr. N. Y. Path. Soc.*, iii. 249; Tarnier et Budin, *loc. cit.*, p. 345; Guellio *Gaz. des Hôp.*, 1886, p. 405.

[3] Goodell: *Lessons in Gynecology*, p. 352.

[4] *Prager Vierteljahrschrift*, 1857.

[5] *Monatsch. f. Geburt.*, 1857, p. 343.

[6] *Wien. med. Presse*, xxvi., 1885, Nos. 18, 20, etc.

[7] *N. Y. Med. Rec.*, 1886, p. 359.

## CONDITIONS OF THE MOTHER WHICH INJURIOUSLY AFFECT THE FŒTUS.

Bearing in mind the absolute dependence of the fœtus in utero upon the maternal structures for the performance of its most important vital functions, it is not difficult to realize the ease with which any disturbance of the maternal economy will react injuriously upon the fœtus. Not only may this unfavorable influence be exerted by certain abnormal physical conditions, as alterations in the quality or quantity of the blood, modifications in the blood-current, or varying degrees of blood-pressure,[4] and changes in the maternal temperature, but also by certain morbid psychical states, as strong emotions, which, in spite of the fact that there is no demonstrable nervous connection between mother and fœtus, exert often a powerful influence upon the latter's growth or well-being—a phenomenon to be explained perhaps by some alteration of the maternal blood that may be produced by a powerful nervous action, as an electrical current can decompose a chemical solution, although there is no definite knowledge as yet of what this change is. The extraordinary effect, however, that powerful emotions in nursing-women have upon their milk, converting it into a rank poison for their offspring, would tend to support this view.

*The Influence of High Temperature upon the Fœtus.*—The well-known experiments of Runge,[1] published in 1877, were for some time accepted as conclusive proof of the great danger to the fœtus of high temperature in the mother. Pregnant rabbits placed in hot box until their body-temperature had risen to 105.8° usually died but almost invariably the fœtuses were found dead upon opening th animal's body immediately after its removal from the box. But i 1883, Doléris[2] showed that if the temperature of the animals wa slowly raised to 105°–106°, and not within an hour, as in Runge' experiments, they seemed to bear it without much inconvenience, eve if long continued, and, if pregnant, their young remained perfectl healthy. These results were confirmed by Runge[3] in a second set o experiments, in which he found, however, that if the animal's temperature was raised, even very gradually, to 109.4°, there occurred the sam symptoms—death of the fœtus and heat-stroke of the mother—as i the temperature had been quickly raised to 106°. Preyer[4] has als shown that the fœtus is capable of enduring a much higher temperatur than was formerly supposed, for in one instance he actually observe a fœtal temperature, in a guinea-pig, of 111.2°, taken in ano, the fœtu living nine minutes, or until the cord was severed and it was remove from the uterus. In view, therefore, of these recent experiments, i seems necessary to modify the views formerly entertained that th existence of fever in the mother of itself must necessarily threate the life of the fœtus, unless, indeed, the temperature should rise suddenly, as in the case of brain tumor described by Runge, or in thos cases of recurrent fever recorded by Kaminski,[5] or else should reac an extreme height, as it might in insolation.

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[1] *Wien. med. Presse,* xxvi. p. 370.

[2] J. Taber Johnson: *Tr. Am. Gyn. Soc.*, vol. iii. p. 107.

[3] There are, however, two recorded cases of this injury occurring from traumatism during pregnancy.

[4] Runge: *Arch. f. Gyn.*, Bd. xiii. p. 488.

As to the treatment of fever in pregnant women with a view to it influence on the fœtus, no special measures would be required as lon as the temperature rose gradually and remained under 105°, but abov this point the danger to the fœtus would begin (Kaminski), and acti antipyretic treatment would be required. Should a pregnant wom die with a temperature as high as 109°, the performance of post-morte Cæsarean section would be useless, for the fœtus would inevitably first, having no means of getting rid of its extra heat by radiati The operation would likewise be fruitless in a case of death after a v sudden rise of temperature (Runge).

*The Influence of Maternal Emotions upon the Fœtus.*—That eit the ovule or the spermatic particle may be impressed with the pec arities, both mental and physical, of the respective individuals from whom they come, no one will deny. And it is equally true that no one can explain the nature of the influence exerted upon, say, a spermatic particle, which will manifest itself perhaps only in the adult life of the individual resulting from the fertilizing action of that spermatozoon, as is the case in hereditary criminal tendencies, in hereditary diseases appearing late in life, or in certain physical peculiarities manifesting themselves after puberty, as, for instance, the enormous moustaches that distinguish the male members of the present reigning house of Italy. But that maternal emotions and impressions are capable of affecting the embryo or fœtus after conception has occurred is by no means generally admitted—is, in fact, by some authorities strenuously denied. Many cases of mental peculiarities or diseases, or of physical defects, that have been attributed to a strong impression upon the mother during pregnancy are no doubt to be explained by the existence of some systemic disease, as syphilis, nephritis, diabetes, cancer, or chronic lead-poisoning in either father or mother, or in the case of intra-uterine amputations by the formation of amniotic bands or the disposition of the cord; but there still remain well-authenticated cases of congenital defects or peculiarities[1] which bear too startling a resemblance to the cause of the impression upon the mother during pregnancy to be dismissed as mere coincidences. The following case[2] may serve as an illustration of the class: A woman was delivered at the seventh month of pregnancy of a dead child which appeared to have no neck. Before showing her the child the attending physician asked her if she had noticed anything remarkable during her pregnancy, when the woman replied that during the first few weeks after conception she had looked into a medical book, and had there seen a picture of a child with the head set directly upon the shoulders—a circumstance which made a decided impression upon her, and one that had caused her considerable uneasiness ever since, for fear her child might be similarly deformed.

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[1] *Arch. f. Gyn.*, Bd. xii. p. 16; Bd. xiii. p. 123.

[2] *Comptes rend. hébd. Séances de la Société de Biologie*, Nos. 28, 29. Doléris' re were confirmed by experiments of Doré (*Arch. de Tocol.*, 1884, p. 141), and q recently by Negri (see abstract in *Nouv. Arch. d'Obstét. et de Gynéc.*).

[3] *Arch. f. Gyn.*, Bd. xxv. S. 1.

[4] *Physiologie des Embryo*, Leipzig, 188

[5] *St. Petersburg med. Zeitung*, 1868, S. 117.

During my term of service at the Philadelphia Hospital there occurred the following case: An Italian woman, ætat. circ. 30, was brought to the obstetrical ward with a large lumbar abscess opening to the right of the spinal column, from which she had been suffering for a year. She was in the sixth to seventh month of pregnancy. After suffering severe pain for some weeks, which required the administration of morphia hypodermatically, she gave birth to a child weighing about four pounds, which had a deeply-congested mark on its back corresponding to the position of the opening of the abscess upon the back of the mother, and upon the infant's arm and forearm were similar spots in the position corresponding to the points upon the mother's arm where it had been customary to administer the hypodermatic injections.

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[1] See the very interesting paper by Dr. Fordyce Barker in *Gynecol. Trans.*, vol. xi., 1886.

[2] Letter from Mr. Brydon of Hawick to *Brit. Med. Journ.*, 1886, i. 142.

It would seem also that a strong emotion on the part of the mother may even be immediately fatal to the fœtus, as apparently happened in a case reported by Hayes.[1]

If there might be a reasonable doubt that the maternal blood may be altered in some unknown manner by a powerful nervous action, there is no question that certain maternal conditions can so modify the blood in its capacity of a bearer of oxygen and nutriment to the fœtus as to seriously interfere with the latter's health, if not to destroy its existence. Such is undoubtedly the case in pneumonia of the mother, which can prevent a proper aëration of the maternal, and consequently of the fœtal, blood, and may so bring about complete asphyxia of the fœtus, or may perhaps result in inspiratory efforts in utero, the inspiration of liquor amnii, and a subsequent development of pneumonia in the fœtus itself.[2] Whatever the cause of death, pneumonia in the mother is exceedingly fatal to the fœtus.

In infectious diseases also the development of specific micro-organisms in the maternal blood may so alter its normal constitution as to render it unfit for the respiratory and nutritive needs of the fœtus, this condition of the blood constituting perhaps the chief peril for the fœtus, for "the fever is usually the least of the dangers to the fœtus in these (infectious) diseases" (Runge). The occurrence also of exanthematous and hemorrhagic endometritis during the course of certain infectious diseases will be considered under the head of Decidual Endometritis.

*Icterus Gravidarum in its Influence on the Fœtus.*—The occurrence of this comparatively rare disease endangers to a high degree the life of the fœtus, either by bringing on an abortion or by first destroying the life of the fœtus through the poisonous action of the bile-salts,[3] or perhaps by the induction of cholæmic convulsions.[4] Thus, Spaeth[5] describes 8 cases, in 4 of which the fœtus was born dead; and Frerichs[6] mentions 3 cases, all fatal to the fœtus. Saint Vel[7] has described an epidemic of jaundice on the island of Martinique, during which, of 30 pregnant women affected, 20 were delivered prematurely, and of these 20 children, 19 were either stillborn or died shortly after birth. Bardinet[8] has also recorded the birth of 6 dead infants out of 13 pregnant women who were suffering from jaundice during an epidemic of the disease in Limoges. Frequently as the bile-salts must traverse the utero-placental septum and enter the fœtal circulation, as evidenced by the high percentage of stillborn children in women affected with jaundice during pregnancy, the coloring-matter of the bile seldom stains the fœtal tissues. Lomer[1] collected 56 cases in which naturally-colored children were born of jaundiced mothers, and 43 more in which the color of the child was not mentioned, so that it was presumably natural; and to these might be added another case described by Parrish. There are 6 recorded cases, however, in which the fœtus or the whole ovum was undoubtedly jaundiced (Lomer).

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[1] *Lancet*, vol. ii., 1874.

[2] See page 281, this volume.

[3] Valenta: *Œsterreichische Jahrb.*, xviii., 1869, S. 163.

[4] Stumpf: *Arch. f. Gyn.*, Bd. xxviii. H. 3.

[5] *Wiener med. Wochenschr.*, 1854, S. 757.

[6] *Klinik der Leberkrankheiten*, 1858, Bd. i.

[7] *Gaz. des Hôp.*, 1862, p. 5

[8] *Union Médicale*, 1863, Nos. 133 et 134.

*Eclampsia.*—It has been estimated that about one-half the children are stillborn after the eclampsia of pregnancy or labor. The cause of the fœtal death is not altogether clear, for it might with equal plausibility be laid to the presence of too much carbonic oxide gas in the maternal blood, to the stagnation of the blood-current during a convulsion, or to the presence of urea or carbonate of ammonia in the blood.[2] As regards the safety of the fœtus, if it is viable a rapid delivery is indicated, although the measures taken to secure this end may, by their additional irritation, only aggravate the disease in the mother.

THE DEATH OF THE MOTHER.—The effect of the death of the mother upon the fœtus is ultimately fatal of course, but as to the length of time that life can continue in the fœtus after it is extinct in the mother there is considerable difference of opinion. Disregarding the expressed view of Kergaredec, that twenty-four hours might elapse between the death of the mother and the fœtus, as preposterous, it is necessary to admit that there is on record a well-authenticated case of the extraction of a living child from the womb of a woman who had been dead two hours.[3] Tarnier[4] also performed post-mortem Cæsarean section upon a woman who during the Commune in Paris had been killed by a stray bullet in the wards of the Maternité, and extracted a living child, certainly three-quarters of an hour—perhaps an hour and a quarter—after the death of the mother. Numerous other instances are recorded of post-mortem Cæsarean operations or the extraction of infants *per vias naturales* at intervals of time ranging from a few minutes to a half hour after the death of the mother. To explain this remarkable survival of the fœtus under conditions which would seem to make life impossible it is sufficient to recall those cases of children born asphyxiated, whose hearts continue beating although they do not breathe for a long time after birth, or to recollect that experiment performed by Haller[1] of forcing a bitch to give birth to her pups water, where they crawled about and lived for half an hour.

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[1] *Zeitschr. f. Geburt.*, xiii. p. 169, 1886.

[2] Perhaps also to the development of ptomaïnes in the blood (Doléris and Butte).

[3] Hubert: *Traité d'Accouchements*, vol. ii. p. 160.

[4] Tarnier et Budin, ii. p. 571.

## The Death of the Fœtus.

The death of the fœtus in utero may be due to many causes may be the result of injuries, deformities, or diseases in the fœtus or in its appendages, the membranes and the placenta. It may b to inherent weakness in either the ovule or the spermatic particle, does not prevent conception, but which renders the embryo inca of development beyond a certain point; or it may be the conseq of a misplaced ovum, as in tubal, ovarian, and abdominal pregna or in those interesting cases of fœtus in fœtu, or of a fœtus enve by the placenta of its twin. The condition of the maternal bloo existence of a very high temperature in the mother, and perhaps s emotions, must also occasionally be held responsible for the destru of fœtal life. All these conditions, however, have been or will be sidered in their appropriate places; but it remains to notice the that the death of the fœtus produces upon the mother, the sig which it may be possible to determine whether the fœtus in ut alive or dead, the habitual death of the fœtus in utero, and the ch that ensue after death in the fœtus itself.

The effect of the death of a fœtus upon its mother may be said practically nil. It is only when the dead body undergoes putref changes, or when, the soft parts being absorbed, there is an attem get rid of the fœtal bones by ulcerative processes into the bla vagina, or rectum, or externally through the abdominal walls, th mother's health and safety are endangered. Thus after ectopic tion the dead fœtus may remain for an indefinite period withi mother's abdomen, without giving rise to greater inconvenience would be caused by the enlargement of the abdomen; but shoul germs of putrefaction gain access to the dead body, as they m reason of the contiguity of the intestines (Litzmann), then a g suppurative peritonitis may be developed and rapidly prove fatal. too, in the retention of blighted ova[2] or in cases of missed labor[3] is usually no evidence of serious harm to the mother until the faction of the dead body begins, when there may be shortly mani all the symptoms of septicæmia, unless the uterine cavity be sp cleared of its contents and well disinfected.

It is by no means an easy matter to determine whether or n fœtus has ceased to live. If its death should have occurred during the early part of pregnancy, the uterus will usually cease developing; the breasts will soon become flabby, although "it is not rare for milk to appear after the death of the fœtus" (Tarnier); the woman may complain of subjective symptoms, as a feeling of weight and discomfort, in the hypogastric region (Lusk); but the doubt will usually soon be solved by the expulsion of the ovum. "It is not rare for the lacteal secretion to be established three or four days after the death of the fœtus, with all the phenomena characteristic of that function after delivery" (Tarnier). Should the fœtus die in the later months of pregnancy, the movements, theretofore perhaps active, will be felt no more by the mother, and the fœtal heart-sounds will no longer be heard. Neither of these signs, however, is entirely reliable, for the woman's statement will not always be perfectly credible, and it is impossible occasionally to hear the fœtal heart-sounds, although the child is alive and well. Negri[1] on one occasion was able to make the diagnosis of fœtal death during pregnancy by abdominal palpation, the fœtus presenting a rather confused outline and giving rise upon pressure of the mother's abdomen over the region of the fœtal head to an indistinct crepitus. His diagnosis was confirmed, as the woman shortly afterward gave birth to a macerated child. During labor a doubt will often arise as to whether the fœtus is dead or alive, and upon the decision arrived at will often depend the performance of embryotomy or of a more conservative operation. Under these circumstances it has been suggested by Cohnstein[2] and Fehling[3] that if the temperature of the uterus be found no higher than that of the vagina, the child may safely be pronounced dead; for the living fœtus, having a higher temperature than its mother, will impart some additional heat to the maternal structures about it. Priestley[4] more practically suggests that the hand be introduced into the uterus in order to feel in the præcordial region for the impulses of the fœtal heart. All these signs, however, will often fail, and the true condition of the fœtus remain in doubt until after delivery.

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[1] *Elém. Physiol.*, vol. iii. p. 314, quoted in Tarnier et Budin, *op. cit.*, p. 570.

[2] See Gehrung: *Weekly Med. Review*, Chicago, 1885, p. 131; *Westminster Reports*, 1885, i. 119; *Tokio Med. Journ.*, 1886, No. 439.

[3] Lusk: *Sci. and Art of Midwifery*, 1886, p. 304.

After death the fœtal tissues will in time saponify (adipocere), partially calcify, mummify, or else be totally or partially absorbed. The phenomena seen shortly after death consist in maceration and putrefaction. Before the second month the product of conception can be entirely absorbed. After that time the changes that take place depend to some extent upon the position of the fœtus. Within the uterus the dead fœtus is first macerated, becoming bloated in appearance, with a grayish-colored skin deprived of its epidermis in spots of greater or less extent, the head enlarged, the cranial bones floating loose under the scalp, and

[1] *Annali di Ostetricia*, May–June, 1885, p. 223.

[2] *Arch. f. Gyn.*, Bd. iv. H. 3.

[3] *Ibid.*, Bd. vii. S. 143.

[4] *Lancet*, Jan. 23, 1887.

the tissues so soft and friable that very slight force is sufficient to detach the limbs from the body. Should air be admitted to the fœtus in this condition by rupture of the membranes, decomposition would rapidly ensue. The other changes that affect the tissues after death in uter are a kind of saponification, and possibly mummification, in whic latter state they will remain for an indefinite period without change It is in abdominal pregnancies that the dead fœtus becomes convert into a so-called lithopædion, which consists, not in a petrifaction of th whole mass, but (1) in a calcification of the membranes after absorptio of the liquor amnii; (2) in a calcification of the membranes and thos points on the fœtus where the membranes adhere to the fœtal surface or (3) in a deposition of lime in the vernix caseosa after the membrane have been ruptured and the fœtus has escaped into the abdominal cavity.[1] The fœtus in the abdominal cavity may undergo all the othe changes that have been described, including putrefaction, and in addition, after all the soft parts have been absorbed, the bony skeleton ma be discharged piecemeal, along with pus, through openings into th bladder, rectum, uterus, and vagina, or externally through the abdominal walls—a conservative action on the part of Nature to get rid of foreign substance; but as a result of the prolonged suppuration th woman may succumb to exhaustion or septicæmia.

THE HABITUAL DEATH OF THE FŒTUS.—There are women wh conceive, perhaps frequently, but who in two or more successive pregnancies, usually at the same period in each, give birth to dead childre It is important in these cases to inquire into the cause of this repeate death of the fœtus, for upon it depends the treatment that may b adopted to secure the birth of a living child. Unfortunately, howeve such an investigation is hampered by the ignorance that as yet su rounds fœtal pathology, and although a considerable advance has bee made since the time when every fœtal death was ascribed to syphilis to a habit of aborting that might be acquired by the mother, yet t future must have much to teach us in regard to the morbid conditio that determine the death of the fœtus.

Although by no means the only cause of the habitual death of t fœtus in utero, syphilis is by far the most frequent one. According Ruge's[2] estimate, 83 per cent. of the premature and stillbirths ar be explained by the existence of syphilis in either parent. But th are many cases in which syphilis can with certainty be excluded, in which the death must be ascribed to one of the other conditions t modern investigation has shown to be occasionally responsible fo repeated interruption of the course of pregnancy.

*Certain Conditions of the Uterus which Interfere with the Developm of the Fœtus.*—There are no reliable statistics in regard to the relat frequency of the causes, other than syphilis, of habitual death of the fœtus, but I should be inclined to place first chronic endometritis, and next perhaps chronic metritis—two affections which are of very common occurrence in child-bearing women, and of their unfavorable influence upon the progress of pregnancy there can be no doubt. Schroeder,[1] among others, speaks of the frequency with which a chronic endometritis can bring about an interruption of pregnancy, either by effusions of blood into the hyperæmic mucous membrane, and the consequent excitation of muscular action in the uterus, or by such an active growth of the decidua that the nutritive blood-supply is so diverted from the fœtus to the uterine mucous membrane that the former perishes.

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[1] Küchenmeister: *Arch. f. Gyn.*, Bd. xvii. p. 153.

[2] *Zeitschr. f. Geburtsh.*, Bd.

Abarbanell[2] first called attention to chronic metritis as a cause of habitual abortion—an effect really to be expected from the excessive development of fibrous tissue in the body of the uterus, which by the loss of elasticity that it entails would interfere with a sufficient dilatation of the uterine cavity. Such, no doubt, is the explanation of that case of Baudelocque's[3] in which, after a Cæsarean section, a woman gave birth to four successive children at the seventh month of pregnancy.

*Alterations in the Maternal Blood that are Fatal to the Fœtus*—Scanzoni[4] has pointed out that a high grade of *anæmia* in a pregnant woman might be fatal to the fœtus; and his statement has been amply verified. The anæmia may be due to an exaggeration of that hydræmia which is characteristic of pregnancy, or to the development of pernicious anæmia,[5] to sudden loss of blood, or to lack of proper or sufficient food. To this last cause may be attributed the large number of abortions and stillbirths that occurred during the siege of Leyden (Hoffmann), or in Germany during the year 1826, when the crops failed (Naegele), and during the siege of Paris (Priestley).

The existence of *plethora* in the mother, on the other hand, has not such an unfavorable influence upon the fœtus, for the very existence of pregnancy usually corrects the evil. It is possible, however, that this condition might prove a predisposing cause to effusions of blood into the membranes or placenta, especially at a time corresponding to a menstrual period, when all the generative organs are disposed to congestion.

*Chronic Diseases of the Mother in their Influence upon the Fœtus.*—Women affected with tuberculosis,[6] cancer, or chronic malarial poisoning[7] may give birth to a succession of dead children—a result, no doubt, of the combined action of the disease itself and the anæmia that accompanies it. Icterus gravidarum also, whether simple, epidemic, or pernicious (see this volume, p. 284), might be a cause of repeated fœtal death, although the course of the last two is usually too rapid to allow of repeated impregnation.

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[1] *Geburtshülfe*, 8th ed., Bonn, 1884, p. 405.

[2] *Monatschr. f. Geburtsh.*, xix. S. 106.

[3] Leopold: *Arch. f. Gyn.*, Bd. viii. p. 253.

[4] *Geburtshülfe*, Bd. ii. S. 3 u. 70.

[5] Gusserow: *Arch. f. Gyn.*, Bd. ii. S. 218.

[6] Tarnier et Budin, *op. cit.*, p. 89.

[7] Bompiani: *Annal. di Ostet.*, vii. 42, 46; Discussion of Dr. Schrady's paper, *Med. News*, 1885, i. 358; Negri: *Annal. di Ostet.*, viii. p. 277.

*Nephritis.*—Fehling[1] has quite recently called attention to the influence of maternal nephritis as a cause of repeated stillbirths. The death of the fœtus is often the result of the morbid condition of the blood-vessels in the maternal portion of the placenta, corresponding to the condition found in the lungs, brain, and other organs in chronic nephritis. This leads to apoplexies and to the formation of large infarcts in the intercotyledonic spaces, which so compress the neighboring placental villi that they cannot perform their physiological functions. The effusion of blood, moreover, can have a more immediately fatal result for the fœtus by causing a premature detachment of the placenta.[2]

Maternal nephritis may be fatal to the fœtus in another way, for Charpentier and Butte[3] have shown that an excess of urea in the maternal blood may prove fatal to the fœtus by the direct poisonous influence of this substance. Disturbances in the maternal blood-pressure (Runge), and insufficient oxygenation of the maternal blood, may also occasionally be responsible for the fœtal death.

*Diabetes.*—This disease seems to have a most disastrous influence upon the fœtus. Matthews Duncan[4] collected the records of 19 pregnancies occurring in 17 women, in 7 of which the fœtus died in the latter part of pregnancy. In 2 cases the children were feeble at birth, and 1 child was diabetic.

*Chronic Poisoning.*—There are certain chemical substances which, taken into the system gradually and in small quantities, but constantly, have a most deleterious influence on the health of the fœtus. Constantin Paul[5] was the first to point out the evil influence of saturnism upon pregnancy. Of 123 conceptions observed by him, 64 ended in abortion, 4 in premature labor, and there were 5 stillbirths; only 10 children passed the age of three years. These observations have been since confirmed by Roque[6] and Rennert.[7]

It has also been asserted that female workers in tobacco are peculiarly liable to abortion or to giving birth to dead infants (Jacquemart, Kostial); but there is as yet some difference of opinion on the subject. Prof. Hunter Maguire of Richmond, Virginia, very kindly inquired for me of some of the largest tobacco-manufacturers in that city in regard to the effect of tobacco on the pregnant women in their employ. It was positively asserted that there was not the slightest evidence to sustain the belief that, in this country at least, tobacco-workers were liable to give birth to dead, premature, or feeble children.

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[1] *Arch. f. Gyn.*, Bd. xxvii. p. 300.

[2] Winter: *Zeitschr. f. Geburtsh.*, Bd. xi. S. 398.

[3] *Trans. Ninth International Medical Congress.*

[4] *Obstet. Trans. London*, vol. xxiv. p. 256.

[5] Tarnier et Budin, *op. cit.*, p. 31.

[6] *Thèse de Paris*, 1873.

[7] *Arch. f. Gyn.*, Bd. xviii. p. 109.

*Causes of Death residing in the Fœtus itself.*—It has been already stated that syphilitic disease of the fœtus or ovum will be by far the most frequent cause of habitual death; but there are other causes residing in the fœtus itself which remain after the rigid exclusion of syphilis. It is well known that deformities may be hereditary in certain families, carried through every member of several generations.[1] So a woman might give birth to a number of children each presenting the same deformity, which might be grave enough to destroy life.[2] There is also a curious affection which Leopold[3] discovered to be the cause of death in several dead fœtuses born successively of one woman. This consisted in a thickening of the fibrous and muscular coat of the umbilical vein to such an extent that its calibre was considerably diminished. This thickening of the coats of the umbilical vein is one of the manifestations of syphilis, it is true, but in Leopold's case there was not the slightest evidence of this disease having existed in either parent.

*The Causes of Fœtal Death referable to the Father.*—In certain cases, where it is impossible to attribute the habitual death of the fœtus to the slightest ill-health of the mother, and where the product of conception itself presents no definite evidence of disease, except, perhaps, an appearance of having been weakly developed, the explanation of the unfortunate termination of repeated pregnancies must be sought in the condition of the father. He may be too old or too young to furnish a fecundating germ of sufficient vigor to enable the fœtus to reach maturity, or he may be the subject of some chronic debilitating disease, as nephritis,[4] diabetes,[4] phthisis,[5] cancer,[6] or chronic lead-poisoning,[7] which may not affect the fecundating power of the spermatic particle, but will render it incapable of performing its part in building up a healthy embryo. Thus, Priestley tells of a healthy young woman whose husband had albuminuria, giving birth first to a sickly infant, and afterward aborting in three successive pregnancies, or until her husband succumbed to uræmia. D'Outrepont also has related the following case: A woman married to a phthisical man became pregnant five times, in each instance giving birth to a dead child at the eighth month. Remarried to a healthy husband, she gave birth to four healthy infants in succession. Paul observed 39 pregnancies in seven women whose husbands were afflicted with saturnism, but of this number there were 11 abortions and 1 stillborn child, while of the 27 children born alive only 9 survived early infancy.

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[1] *Br. Med. Journ.*, Jan. 22, 29, 1887; *Am. Journ. of Obstet.*, 1886, p. 1108.

[2] A lioness in the Philadelphia Zoological Garden has given birth, on three separate occasions, to cubs that were deformed about the jaws and palate, and lived only a few moments after birth.

[3] *Arch. f. Gynäk.*, Bd. x. p. 191.

[4] Priestley: "Lumleian Lectures on the Pathology of Intra-uterine Death," rep. from *Brit. Med. Journ.*, 1887, p. 8.

[5] D'Outrepont: *Neue Zeitschr. f. Geburt.*, 1838, Bd. vi. p. 34.

[6] Jacquemier: *Dict. Encyc. des Sc. méd.*, art. "Avortement," vol. vii. p. 537.

[7] Constantin Paul: *loc. cit.*

*The Habit of Giving Birth to Stillborn Children.*—If one can exclude all the causes in the mother that have been enumerated as responsible for the death of the fœtus, if there is no sign of abnormality or disease in the fœtus or ovum, or if there is nothing in the condition of the father that might account for the repeated stillbirths, then their occurrence may be attributed to a habit of the mother of giving birth to dead children. Such cases are extremely rare, as may be imagined, but are by no means unknown. Two examples may be cited: A woman[1] subjected to a severe fright in the last month of pregnancy afterward gave birth to a dead child. In twelve successive pregnancies she gave birth to dead children at the seventh month. The mother[2] of Hohl gave birth alternately to living and dead children. The first child was living and healthy, the second dead, and so on till the tenth pregnancy, when so certain was the lady that her child would be born dead that she provided nothing for it. It was born alive, however, and was no other than Hohl himself.

*To Determine the Cause of Repeated Stillbirths.*—The suspicion of syphilis in the parents will usually be the first to arise in the mind of a practitioner who meets with a case of habitual death of the fœtus; but, aside from the possible injustice of such a suspicion, it may suggest a false system of therapeusis. It is therefore most important to discover the true cause of the inability of the woman to bear a living child, for the treatment that may be adopted to prevent a repetition of the stillbirths must differ most radically with each of the many causes that have been enumerated above. Syphilis, as by far the most frequent cause of habitual death of the fœtus, must be first excluded before another cause is sought. But this is by no means always an easy matter. If there is a distinct history or evidence of syphilis in either parent, or if the child is born with an extensive pemphigoid eruption, especially on the soles of the feet or palms of the hand, the diagnosis is easily made. It more frequently happens that the history of the parents is obscure, and that the fœtus is expelled already macerated or with no distinctive marks of disease upon its body. In such a case a careful examination of the fœtal body will usually reveal unmistakable evidence of the existence of syphilis. The most valuable signs of fœtal syphilis are three in number: (1) An osteo-chondritis, which can best be seen between the head and shaft of the femur, but may be detected between the epiphyses and diaphyses of all the long bones, giving rise to a ragged yellowish line of premature ossification undergoing fatty degeneration that can readily be made out with the naked eye; there is along with this very often a detachment of the epiphysis from the diaphysis. Wegner[1] first called attention to this sign of fœtal syphilis, and in Germany it is known by his name. Much importance was attached to it by the late Prof. Schroeder,[2] and I have myself found it of value in the Philadelphia Hospital. (2) According to the careful experiments of Ruge,[3] the liver of a newborn infant should form one-thirtieth part of the total body-weight. In syphilitic infants, however, this proportion is always exceeded, the liver reaching in some instances one-twelfth or more of the total body-weight. (3) According to the same authority, the spleen should form one-three-hundredth part of the total body-weight. This organ is also, however, much enlarged in syphilis, weighing, according to Lomer, much more than its due proportion to the weight of the fœtus. These three signs, then, taken together, make the diagnosis of syphilis reasonably sure. If in addition there are found inflammation of the serous membranes and gummatous formations in the placenta, the diagnosis becomes all the more certain.[4]

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[1] Hayes: *London Lancet*, 1874, vol. ii.

[2] Tarnier et Budin, *op. cit.*, p. 365.

If, however, it is possible to exclude syphilis as a cause of the recurring death of the fœtus, another cause must be sought. It will be necessary to learn the condition of the uterus, whether there be inflammation of its lining membrane or body, or whether the whole organ is displaced or its cervix lacerated. Should the appearance of the patient suggest either anæmia or plethora, the blood must be examined. The lungs should be examined for phthisis, and the urine for sugar or for albumen and casts. The history of the patient may point to the existence of malaria or of chronic lead- or tobacco-poisoning. Physical signs may denote a cancer, or there may be unmistakable jaundice. The fœtus itself must be examined for some hereditary defect, and the cord for stenosis of the umbilical vein. Finally, the condition of the father must be inquired into—whether he be too young or old or the subject of some debilitating disease. If all these signs fail, then the diagnosis must rest upon a habit or an hereditary predisposition of the mother.

*The Preventive Treatment of Habitual Death of the Fœtus.*—The measures to be adopted to prevent the repetition of a stillbirth must depend upon the cause that has given rise to the death of the fœtus in the past. In the case of syphilis of the parents an appropriate antisyphilitic treatment should be adopted and continued for many months; and it would be advisable to interdict, or at least very much restrict, sexual intercourse during the duration of the treatment, in order to spare the woman the discomforts or dangers that might attend another pregnancy ending in abortion if impregnation should occur before the specific virus was thoroughly eliminated from either parent. So frequently is an antisyphilitic treatment successful in these cases that certain writers have recommended the administration of potassium iodide or mercury to every woman who was in the habit of giving birth to dead children. Such a practice, however, would be irrational, and in some cases perhaps harmful. If syphilis can be excluded, or if a woman in any case first comes under observation after impregnation has occurred, a treatment first suggested by Simpson[1] with a view of increasing the oxygenating power of the maternal blood might be adopted. This consists in administering to the pregnant woman large doses of chlorate of potassium, which, by the large proportion of oxygen it contains, is supposed to supercharge the maternal blood with the gas, and thus compensate for the diminished area of effective placenta in cases of fibrous or other degeneration of that organ. Whatever the explanation, this treatment certainly met with success in the hands of its originator, and has since been recommended, among others, by Bruce, Inglis, Carl Braun, Fordyce Barker, and Penrose. If there should be a chronic endometritis, its treatment by the curette may be followed by conception and a normal pregnancy.[2] A correction of a displacement of the uterus or a repair of a lacerated cervix may be followed by the same happy result. In anæmic women a tonic treatment, especially with the salts of iron, will often be followed by the birth of a vigorous infant, although the woman may have previously had a succession of premature stillbirths. If along with the iron the patient obtains change of air and scene and a life in the open air, the effect will be all the more decided. These combined advantages are be best obtained at some of the well-known chalybeate springs in th country and in Europe, such as those in Western Pennsylvania Virginia, or those of Pyrmont, Schandau, Schwalbach, or Neuhau Plethoric patients, on the other hand, would be benefited by increas exercise, by frequent depletion, and by a restricted diet, or a cour of the waters at Saratoga, Kissingen, or Carlsbad might be benefici Phthisis, cancer, diabetes, or nephritis in the mother renders the prognosis for the fœtus grave; especially in the last does treatment seem to be of no avail (Leopold). In chronic malarial-, lead-, or tobacco poisoning the elimination of the poison should enable the woman to bear a living, healthy child.

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[1] *Virchow's Archiv*, Bd. l. p. 305.

[2] *Zeitschr. f. Geburt.*, Bd. i.

[3] See Lomer: *Zeitschr. f. Geburt.*, Bd. x.

[4] Lomer: *loc. cit.*

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[1] Sir J. Y. Simpson: *Obstet. Memoirs*, ed. by Priestley and Storer, Edinb., 1865–55, vol. i. p. 460.

[2] Schroeder: *Geburtshülfe*, 8th ed., p. 405.

A chronic, incurable disease in the father may so deteriorate the quality of the spermatic particles that, while conception may occur, the development of the embryo will be impossible. Should his condition, however, admit of improvement, the male fertilizing element may gain sufficiently in vigor to perform its part in the growth of the fœtus.

There are women who carry a living child up to a certain period of pregnancy, but if allowed to go to term give birth repeatedly to dead infants. Thus, Tarnier[1] tells of a woman, apparently in good health, who gave birth to thirteen dead children successively, although it was demonstrated that the fœtus was in each instance alive until the last month of pregnancy. The same authority cites another instance of a woman who in seven successive pregnancies experienced the active movements of her child until within fifteen days of the normal time of delivery, and yet always gave birth to a dead infant. In such cases as these it is evident that the birth of a living child could be secured by inducing premature labor at a time before the period of pregnancy at which the accustomed death of the fœtus occurred. It will often be peculiarly gratifying to the physician to secure to a woman the birth of a living child after several abortions or stillbirths have occurred, from its possibly important bearing upon domestic happiness or the inheritance of property. With a careful inquiry into the cause of the previous failures to bear living children, and a judicious adaptation of the treatment to the cause, the efforts to prevent a recurrence of the habitual death of the fœtus will usually be crowned with success.

## ABNORMALITIES, DEFORMITIES, AND MONSTROSITIES OF THE FŒTUS.

An exhaustive study of the innumerable deviations from a normal development that may be found in the fœtus has become a work of such magnitude that it must be left to the teratologist, and can no longer be included in a practical work on Obstetrics. It is a subject, however, that must have some interest for every obstetrician, and therefore for convenient reference a classified table of the anomalies and monstrosities most frequently met with is appended, along with a very brief description of the most interesting deformities that may at any time occur in the course of an active practice. The classification of Geoffroy St.-Hilaire has been adopted, as on the whole the best, following in this the example of Tarnier. This classification is open to the objection, however, common to all attempts at separating the anomalies and deformities of the fœtus from the monstrosities—that it is impossible to draw a sharp dividing-line between the two.

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[1] *Loc. cit.*, p. 365.

Every fœtus that presents any deviation from the normal may be classed as

(1) Hemiteratic;[1]
(2) Heterotaxic;[2]
(3) Hermaphroditic;[3] or,
(4) Monstrous.

The HÆMITERATA may be classified as follows:[4]

*Anomalies of Growth.*—Dwarfed or gigantic children; retarded or precocious development.

*Anomalies of Volume.*—Smallness of limbs; defective development of muscles, of the breasts, of the thymus gland, of the vagina, etc.; excessive size of the head, of the breasts; lactiferous breasts in the male, etc.

*Anomalies of Form.*—Deformities of the head, anomalous forms of stomach, uterus, vagina, pelvis, etc.

*Anomalies of Color.*—Complete or partial albinism or melanism.

*Anomalies of Structure.*—Cartilaginous condition of bones, abnormal ossification, etc.

*Anomalies by Displacement of the Splanchnic Organs.*—Encephalocele, meningocele, displacement of the thoracic and abdominal viscera, as in eventration, extrophy of bladder, tardy or precocious descent of the testicles, etc. etc.

*Anomalies by Displacement of Non-splanchnic Organs.*—Club-foot, curvature of spine, displacement of vessels, etc.

*Anomalies by Change of Connection.*—Abnormal articulations of bones, abnormal implantation of teeth, abnormal attachments of muscles and ligaments, abnormal branches of arteries and nerves.

*Anomalous Openings.*—Abnormal openings of the vessels into the heart, of the thoracic duct, of the vagina, the intestines, the urethra, the ureters; abnormal existence of a cloaca.

*Anomalous Imperforations.*—Imperforation of the rectum, vulva, urethra, œsophagus, mouth, pupils of iris, etc. etc.

*Anomalous Union of Organs.*—Union of the kidneys, testicles, fingers, toes, teeth, ribs, etc.; adhesion of the tongue to palate.

*Anomalies by Disjunction.*—Persistence of the urachus (patulous), of the ductus arteriosus, fissures of various organs, hare-lip, epispadias and hypospadias, sternal fissure, and spina bifida.

*Anomalies by Numerical Diminution.*—Absence of muscles, of l bones, vertebræ, ribs, teeth, digits; of a lung, a kidney; of the uterus, the vagina, or the bladder.

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[1] From ἥμισυς, the half; and τέρας, monster.

[2] ἕτερος, other; τάξις, order.

[3] Ἑρμῆς, Mercury, and Ἀφροδίτη, Venus.

[4] Tarnier et Budin, *op. cit.*, p. 390.

*Anomalies by Numerical Augmentation.*—Supernumerary muscles, tendons, ribs, teeth, fingers, and breasts; uterus didelphis.

The second division of fœtal deformities consists in the so-called HETEROTAXIS, or "the simple change in the situation of the viscera." This may involve only the internal organs (splanchnic inversion) or the external also (general inversion). Thus the cardiac end of the stomach may lie to the right side; the heart may be transposed to the right side; the main development of the liver may be upon the left side; the large abdominal vessels may have their positions transposed. This may be accounted for by the fact that the development of the organs that become ultimately unilateral occurs primarily in a symmetrical manner in the median line; one or the other side atrophies, and the other goes on to its normal development. Should this normal arrangement be interfered with, a growth in an unusual situation may be the result.

HERMAPHRODITISM.—There is a time in fœtal life when the elements of both sexes seem to be present in equal force. The duct of Müller and the duct of Wolff lie side by side; the sexual eminence contains the germs of both an ovary and a testicle; and the elevation which subsequently forms either the clitoris or the penis is prepared to develop indifferently into either organ. But as the determination of sex becomes evident, in the case of a female the duct of Müller develops, while the Wolffian duct atrophies; the female elements of the primordial tissue constituting the so-called sexual eminence develop into an ovary, and the external elevation becomes converted into a clitoris, while the skin around it arranges itself into the labia majora and minora, leaving a cleft in the median line to communicate with the vagina, which, with the uterus and tubes, has been formed out of the ducts of Müller.[1] Such, briefly, is the normal development of the female sexual organs.

But this normal growth is sometimes replaced by most curious deviations from the natural development. Both the male and female elements in the fœtus may grow with equal vigor, and the bisexual development may persist till adult life, so that one individual may possess ovaries, tubes, a uterus, and a vagina, along with a penis, scrotum, and testicles. Such a person is a true hermaphrodite in the strictest sense of the modern interpretation of the term, but true hermaphroditism may be said to exist even when there is not such a complete development of all the male and female organs in a single individual. Thus there may be an ovary on one side and a testicle on the other;[2] there may be testicles and ejaculatory ducts with the external genital organs of a woman, or two testicles with a clitoris, labia, vestibule, and vagina. These true hermaphrodites—that is, individuals possessing, in whole or in part, the sexual organs of both sexes—must be distinguished from those males affected with a marked hypospadias, associated perhaps with extrophy of the bladder. While a student in the Philadelphia Hospital I saw such a person who had been educated and clothed as a girl until his nineteenth year.

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[1] Fowler: *Am. Journ. Obstet.*, April, 1887, p. 423.

[2] Three such cases are reported by Berthold, Barkow, and Meyer: Tarnier et Budin, *loc. cit.*, p. 415.

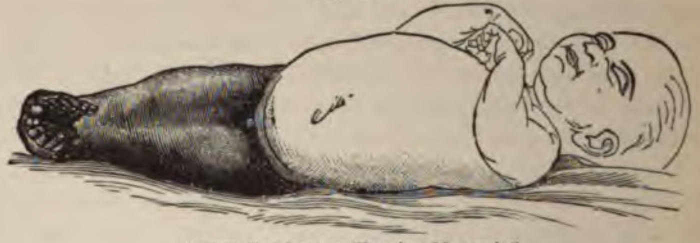
MONSTROSITIES.—A monstrosity is a creature exhibiting a congenital deformity of such gravity as to be incompatible with life, or which impresses the beholder with such wonder, disgust, or horror that the ancients regarded it as a sign (*monstrum*) of the displeasure of the gods. The etiology of these monstrous productions is often obscure, although they are occasionally explained by the existence of syphilis of the ovum, inflammation of the fœtal serous membranes or of the amnion, maternal impressions, or the unfavorable influence of one fœtus upon the other in multiple pregnancies. They may be divided into two great classes—the single and composite monsters. Single monsters may be further classified as follows:

A. *Autositic Monsters.*—These are so called because they obtain their own nourishment; that is, they are not dependent upon the circulation of another fœtus, as are the Acardias. They are divided into—

(1) *Ectromelic Monsters.*—In these there is an aborted development of the limbs (ἐκτρώω, to abort; μέλος, a limb).

(2) *Symelic Monsters.*—This deformity consists in a union, more or less complete (sirens), of two limbs of a single fœtus.

FIG. 182.



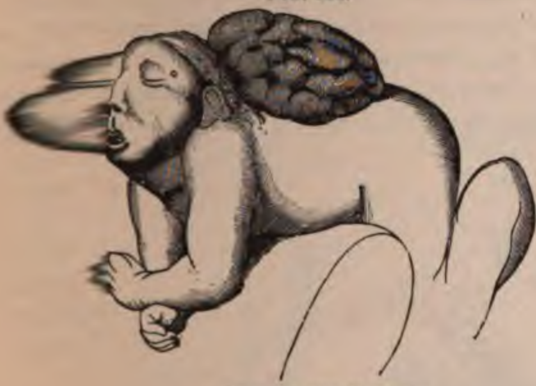
A Symelic Monster (Tarnier, Maternité).

(3) *Celosomatic Monsters* (κήλη, hernia; σῶμα, body).—In this variety there is a more or less complete eventration, associated with other deformities, of the limbs and genito-urinary organs.

(4) *Exencephalic Monsters.*—Here a badly-formed brain is situated more or less without the cranium, which is itself malformed.

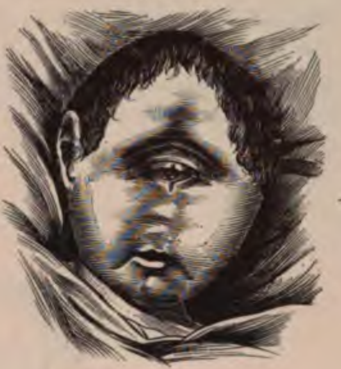
(5) *Pseudencephalic Monsters.*—In this class the vault of the cranium is wanting, but there remains a vestige of the brain in the shape of a small tumor made up of blood-vessels and nervous tissue.

FIG. 183.



Exencephalic Monster.

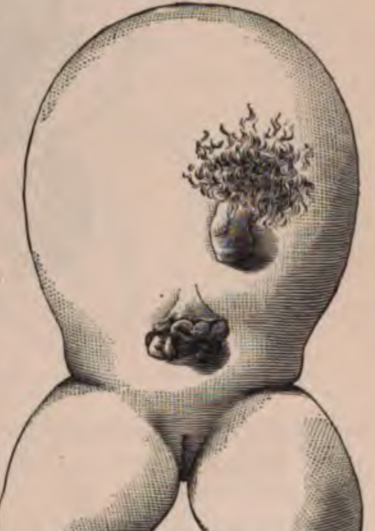
FIG. 184.



A Cyclops (Tarnier, Maternité).

(6) *Anencephalic Monsters.*—This monstrosity is of not infrequent occurrence. Here, too, the vault of the cranium is wanting, but there is no trace of a brain. The head is set close upon the shoulders, which are unusually broad and well developed, as indeed is the rest of the body, and the eyes are prominent and staring.

FIG. 185.



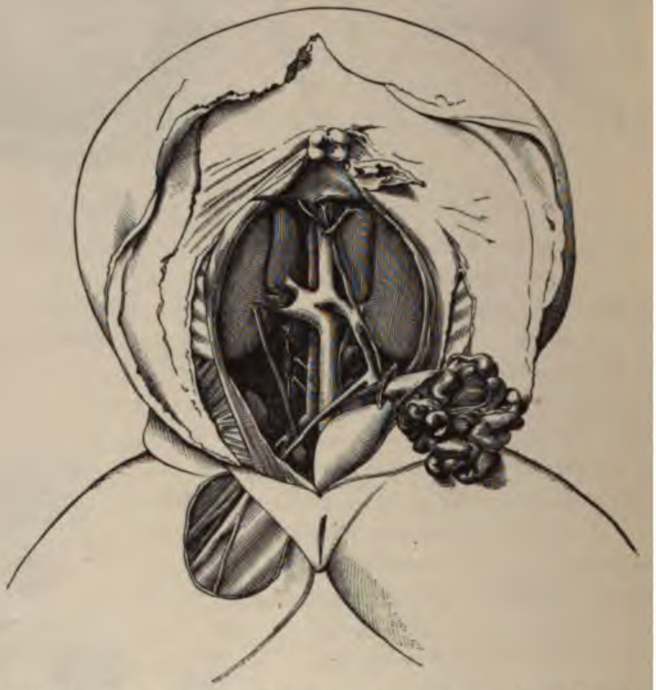
An Acephalic Monster (Veendam).

(7) *Cyclocephalic Monsters* (cyclops).—In these creatures the nose is wanting and the two eyes, usually imperfectly developed, converge toward the median line, and are, as a rule, intimately united with one another.

(8) *Otocephalic Monsters.*—This monstrosity is distinguished by the convergence of the ears, and occasionally their union in the median line. There is an accompanying defective development of the lower portion of the skull.

B. *Omphalositic Monsters.*—This form of monster leads a parasitic existence in utero, receiving its nourishment from another fœtus, which is usually strongly developed. The explanation of this form of monstrosity is to be found in the fact that when two embryos are developing within a single chorion, one often exceeds the other in strength, and the circulation of the stronger fœtus, m that of the weaker one in the placenta, reverses it, and thus r the latter's heart useless, which as a consequence atrophies and pears (acardia). And the fœtus itself grows as a more or less sha mass, sometimes without a head (acephalic), rarely without a

Fig. 186.

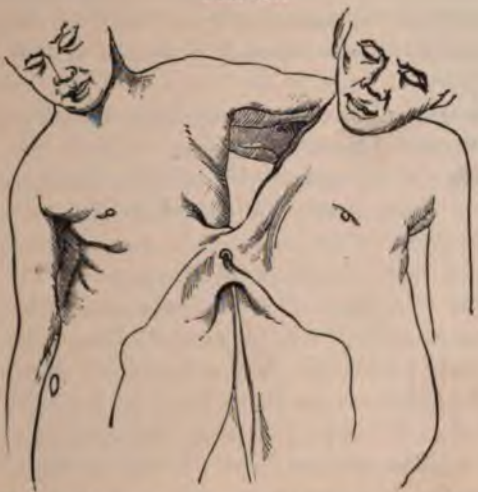


An Acephalic Monster, showing on dissection the acardiac condition (Veendam

(asomatic), and occasionally presenting none of the characteristi would distinguish it as the offspring of a human being (fœtus phus, anideus).

Composite Monstrosities.—Composite monsters are formed union, more or less complete, of two or more fœtuses. Various t have been advanced to account for this union. It has been a to some condition of the ovule or of the spermatic particle befo ception; it has been said that each embryo began its developme arately, and that they afterward united, or that the embryo wa inally single, but in a certain period of its growth took on formation. The most reasonable belief would seem to be t nucleus of the ovule has the power of dividing itself by fissi that during the process of division, before the two were com separated, impregnation occurred.

FIG. 187.

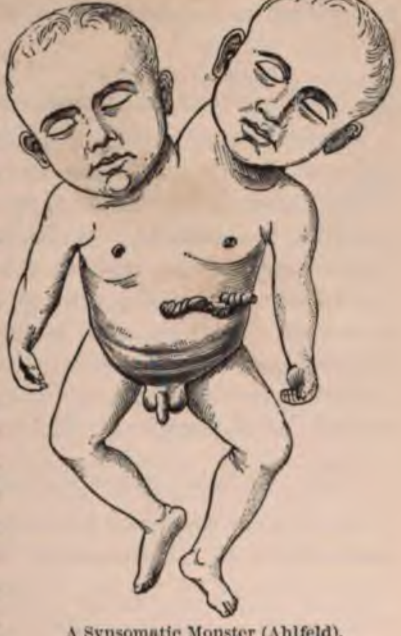


The Siamese Twins (xithopagus). (From a plaster cast in the College of Physicians.)

Composite monstrosities may be classified as follows:

A. *Double Autositic Monsters*, which are subdivided into—

FIG. 188.



A Synsomatic Monster (Ahlfeld).

(1) *Eusomphalic and Monomphalic.*—These monsters have respectively each a well-formed umbilicus or a single umbilicus. In this class are included the monsters united at the sternum (sternopagus), the pelvis (ischiopagus), the head (cephalopagus), the xiphoid cartilage (xithopagus), etc.

(2) *Syncephalic and Monocephalic Monsters.*—In the first variety there is not only a junction, but an intimate fusion, of the two heads, the bodies remaining separate; and in the monocephalic monster the junction and fusion are even more complete, so that it would be difficult to distinguish the composite nature of the deformity, were it not for the separate bodies.

(3) *Synsomatic and Monosomatic Monsters.*—This deformity consists in a fusion more or less complete of the two trunks, the heads remaining separate and distinct, the difference

between the synsomatic and the monosomatic variety being one only of degree. The latter is distinguished by a fusion so complete that it is difficult or impossible to demonstrate the line of demarkation betwee the two bodies.

B. *Double Parasitic Monsters* may be further subdivided into—

(1) *Heterotypic and Heteralien.*—These monsters are distinguish (1) by the insertion of the parasitic fœtus at some point in the anteri abdominal wall of the autositic individual, sharing its umbilical cor and (2) by the insertion of the parasite at a distance from the umbili cord of its host. These varieties are very rare.

(2) *Polygnathic Monsters.*—This deformity consists in the attachme of a parasitic fœtus, more or less imperfectly formed, to the upper j (epignathus) or to the lower jaw (hypognathus) of the autositic fœtus

(3) *Polymelic Monsters.*—In this variety of monsters one or mo limbs of a parasitic fœtus project from various portions of its ho

(4) *Endocymatic Monsters.*—Under this name (κῦμα, the fœtus, a ἔνδον, within) is classed what are to-day more commonly called de moid cysts, containing often not only organs directly derived from t epidermis, as tissues having the formation of eyes, breast, etc., but al bones, feet, etc. In this class, too, belong those interesting and ra cases of fœtus in fœtu.[1]

C. *Triple Monsters.*—These, as Tarnier says, "occur only as extreme rare exceptions in triple pregnancies, which are themselves rare."[2]

## ABORTION, MISCARRIAGE, AND PREMATURE LABOR.

The term "abortion" is usually applied to the expulsion of the ovu before the fourth month, at a time when the placenta is not yet diff entiated from the rest of the chorion. Premature labor signifies, to t majority, the delivery of a fœtus that has become viable. For t expulsion of the ovum during the intervening time from the fourth the seventh month of pregnancy a distinctive term is needed, as t process, in combining some of the features of both abortion and p mature labor, presents a clinical picture different from either of the To denote the interruption of pregnancy at this time the word "m carriage" will here be used.

### THE CAUSES OF PREMATURE EXPULSION OF THE OVUM.

Many of the conditions which interrupt the course of pregnancy ha been referred to. The death of the fœtus; abnormalities and disea of the membranes, including the deciduæ; pathological conditions of the placenta and apoplexies of the ovum; traumatism and certain diseases of the mother,—have all been noticed. But the maternal diseases have been regarded chiefly as to their effect directly upon the embryo, fœtus, or ovum. There are, however, certain conditions of the mother which have as their primary effect the active contraction of the uterine muscle, which results secondarily in the premature expulsion of the ovum, although the latter may be normal in every respect.

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[1] Dumas: *Arch. f. Gyn.*, Bd. vii. p. 384.

[2] This table of monstrosities is taken, very much condensed, from Tarnier et Bud vol. ii., *Traité de l'Art des Accouch.*, pp. 418–472. For fuller information the reade referred to that excellent treatise on the pathology of pregnancy.

*Irritable Uterus.*—From clinical observation one must feel inclined to ascribe to every uterus a special temperament, which, as the case may be, is irritable, equable, or apathetic. It is notorious that some pregnant women are liable to lose the product of conception from a trivial cause. A long walk, a dose of some mild purgative, the jolting of a carriage, a misstep, especially while descending a staircase, not to mention exercise on horseback or dancing, have been followed by the expulsion of the ovum. A case of this sort is known to the writer. A young primigravida was recommended by her physician to walk a mile every day in the open air. This advice was followed but once or twice, when premature labor came on, for which no other cause could be assigned than the very slight physical exertion that had been made. In such cases the greatest care must be exercised to guard the woman from anything which might stimulate uterine contractions, and at the time corresponding to the menstrual period the precautions must be doubled. If this disposition to abort is noticed in a woman who has borne a child at term, it would be well to examine the cervix, for an extensive laceration in that quarter will account for some cases of habitual abortion, and a repair of the injury will enable the uterus to retain an impregnated ovum. Very many other causes might be enumerated that would induce a pregnant uterus to expel its contents when the uterine muscle is prone to respond too readily to any stimulus. Congestion of the pelvic organs, common in prostitutes, who ply their trade regardless of their condition, may account for the abortions that occur so frequently in these women. The same condition, due perhaps to over-frequent marital relations, to working the treadle of a sewing-machine, or simply to the chronic constipation characteristic of civilized woman, may excite an irritable uterus to action. Reflex stimulation of the womb, as from irritation of the nipples while suckling a child, from some trifling operation like the extraction of a tooth, from the scratching of the vulva induced by pruritus, or from a diseased ovary, will be sufficient, in some cases, to set up active uterine contractions. The opposite picture, while not so familiar, is occasionally seen. Some women can make the most violent exertions, can receive the roughest treatment, without bringing their pregnant condition to an end. English writers tell of ladies who follow the hounds over the most difficult country in the early months of pregnancy without aborting. The case of a pregnant woman who was thrown upon the ground and whose abdomen was stamped upon, but who, nevertheless, went on to term, has been described. Sounds have been introduced into the pregnant uterus; intra-uterine injections have been given;[1] strong applications have been made to the endometrium; trocars have been plunged through the uterine wall;[2] pregnant women have been thrown violently from a carriage;[3] in one case a young girl, five months pregnant, cast herself from the Pont Neuf into the Seine;[3] in another fifteen leeches were applied to the cervix of a pregnant uterus;[3] Emmet's operation has been performed upon the cervix during the second month of pregnancy;[4] ovariotomy and other serious surgical operations have repeatedly been performed,—all without inducing abortion or premature labor.

### SPASMODIC MUSCULAR ACTION IN THE MOTHER AS A CAUSE OF PREMATURE EXPULSION OF THE OVUM.

Pregnant women affected with chorea, eclampsia, uncontrollable vomiting or coughing, epileptic, hysterical, or cholæmic convulsions, or with tetany, are very liable to expel the product of conception prematurely.

*Chorea.*—Less than half of the women affected with chorea gravidarum will go on to term. Of 57 cases collected by Barnes, only 22 completed the full time of pregnancy. Bamberg's statistics of 64 cases show 33 arrived at term, and Spiegelberg of 69 cases saw only 29 delivered of mature infants.[5]

The reason for the premature termination of pregnancy in these cases is not quite clear. Perhaps the physical exhaustion due to almost incessant muscular action explains it. It may be that the muscular contraction disturbs the venous circulation, brings about a stasis in the uterine veins and a consequent excess of carbonic oxide gas, which may excite the uterine muscle to action (Brown-Séquard). In a case recently under my observation the uterine muscle toward the end of pregnancy seemed to partake in the choreic movements that convulsed the muscles of the extremities. Through the abdominal wall the uterus could be felt firmly contracting at intervals of not more than a minute. Every contraction was extremely painful, but during the four days that this cor dition of the uterus lasted the os showed no sign of dilatation. The suffering finally became so great that labor was induced by Krause's method.[1]

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[1] Scanzoni: *Lehrb. der Geburts.*, Wien, 1867, p. 83.

[2] Many cases are reported of tapping a uterus distended by hydramnion in mis[illegible] for an ovarian cyst or ascites.

[3] Tarnier and Cazeaux, 8th ed., p. 567.

[4] Juillard: *Nouvelles Archives d'Obstét. et de Gynéc.*, 1886, p. 645.

[5] Hervé: *Thèse de Paris*, 1884.

*Eclampsia.*—The eclampsia of pregnancy in the great majority of cases determines the premature expulsion of the ovum. Frequently, no doubt, the life of the fœtus is first destroyed; often, however, the immediate effect is seen in expulsive efforts of the uterus, due to the asphyxia of the organ, to the irritating effect of urea, carbonate ammonia, or ptomaïnes in the blood, or perhaps to the fact that the uterine muscle shares in the convulsive action of the whole muscular system.

*Uncontrollable Vomiting and Coughing.*—The constant violent action of the diaphragm in cases of uncontrollable vomiting and coughing during pregnancy often leads to the expulsion of the ovum. Of 51 cases of uncontrollable vomiting collected by Guéniot, 20 ended in abortion or premature labor.[2] A violent and persistent cough will also, in rare instances, by the constant succussion in the abdominal cavity, be the cause of prematurely expelling the ovum.

*Epileptic, Hysterical, Cholæmic, and Tetanoid Convulsions.*—According to Tarnier, attacks of epilepsy during pregnancy can be disastrous for the fœtus, either in killing it outright or in bringing about its premature expulsion. Tanner mentions a case of hysterical convulsions which was followed by the expulsion of a dead fœtus at the seventh month.[3] Cholæmic convulsions occur perhaps more frequently than is generally suspected,[4] and they always interrupt pregnancy, either by the death of the mother or the expulsion of the ovum. Meinert[5] has recently collected 11 cases of a tetanoid condition in pregnancy, in 6 of which there was true tetany. In 2 of the 11 cases dead children were born, one prematurely at the seventh month, the other at term. In one other case the child was expelled at the eighth month, and in another eleven days before term.

*Conditions of the Maternal Blood which Stimulate the Pregnant Uterus to Expulsive Efforts.*—The poisons of all the infectious diseases in the maternal blood are more or less liable to excite active contractions in the pregnant uterus. Whether this is due to some irritative action of the micro-organisms or to the development of leucomaïnes,[6] or to a diminution of the oxygenating power of the blood, as yet remains in doubt. The last condition, however, must be called upon to explain the abortions occurring so frequently during an attack of pneumonia, as well as in cases of chronic heart disease, in which the circulation is much interfered with. It is possible also that powerful emotions the blood in some way that would account for the action of the u when women have been badly terrified. But it is more likely tha action is analogous to that of the rectal and vesical muscles in case nervous defecation and urination. Thus, Baudelocque used to te his lectures how, after the explosion of the powder-mill of Gre he was called to see 62 women either aborting or threatened wit abortion.[1] In all maternal diseases accompanied by fever the the irritation of the uterine muscle might be held responsible for the ex sive efforts of the uterus; but there are in these cases other condi offering a more probable explanation for the abortion. There i acute infectious febrile affection not often referred to in work Obstetrics, and which has not yet been noticed here—*miliary feve suette miliaire* of the French. This disease occasionally appears a epidemic in certain parts of Italy, Switzerland, and France; it us accompanies or follows an epidemic of one of the exanthemata, a characterized by a very peculiar train of symptoms. There i initial chill, followed by sweating and fever; on about the fourth there appears an eruption, first upon the buttocks, spreading rapid the forearms and breast, consisting of little vesicles, sometimes and transparent like sudamina, again surrounded by an areol inflammation, or appearing first as red spots exactly like thos measles, in the centre of which finally develop the vesicles. De mation begins about the eighth day. There is such profuse swe for the first six or seven days of the disease that the patients change their linen three or four times in the twenty-four hours; are intense headache and insomnia. There is a feeling of great op sion about the chest or thoracic constriction, usually coming on at when the sweats are most marked. In women there is often me rhagia, and in both sexes epistaxis. Dr. Parmentier[2] has rec described in a most interesting manner an epidemic of this di In all, there were 2068 persons attacked, of whom 131 died—a tality of 6.3 per cent. But among the sufferers there were 9 preg women; of this number, 5 died, 2 recovered after aborting, and in 2 cases had the disease no influence on the pregnancy. A mortali 55½ per cent. in pregnant women, contrasted with the mortality o disease in general, 6.3 per cent., shows that the condition of preg increases the gravity of the prognosis in this as in most of the acute febrile affections.

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[1] For a report of the case see *Trans. Philadelphia Obstet. Soc.*, Dec., 1887.

[2] See Tarnier et Budin: *op. cit.*, p. 59.

[3] *The Signs and Diseases of Pregnancy*, London, 1867, p. 304.

[4] Stumpf: *loc. cit.*

[5] *Arch. f. Gyn.*, Bd. xxxi. S. 444.

[6] A. M. Brown: *Treatise on Animal Alkaloids*, London, 1887.

*Uterine Contractions Excited by an Abnormal Situation or Po of the Uterus.*—Retroflexion and prolapse of the gravid womb us lead to abortion, for the uterus is unable to properly expand in its unnatural position. This is true likewise of pregnancy in one horn of a deformed uterus.[1]

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[1] See Tarnier et Budin: *op. cit.*, p. 477.

[2] "Epidémie de Suette miliaire: ses Caractères dans le Canton de Lussac-les teaux," *Revue de Médecine*, Sept., 1887.

Perimetritis also, resulting in adhesions between the uterus and neighboring organs, or cellulitis, with plastic exudate in the broad ligaments, as well as diseases of a tube and ovary leading to adhesions, will, if pregnancy should occur, usually interrupt its course by interfering with the expansion of the gravid womb. Fibro-myomata of the uterine wall may act in the same manner, or else by the congestion of the organ to which they lead, or by acting as a mechanical irritant may stimulate the uterine muscle to contraction.

*Over-distension of the Uterus as a Cause of Premature Expulsion of the Ovum.*—If the uterus is unduly distended in hydramnion or in cases of multiple pregnancy,[2] especially where there are three or more fœtuses, the distension of the muscle often irritates it to expulsive efforts.

*In twin pregnancies*, should one fœtus die, the uterine muscle is occasionally stimulated to contraction, and the entire uterine contents are cast off, although the remaining fœtus may be healthy and normal. In cows epidemics of abortion have been observed, which have been attributed to a specific form of micro-organism, said by Franck and Roloff to resemble the leptothrix buccalis.[3] Brocard[4] has recently called attention again to this disease. It is improbable that the same disease can affect a woman, but in lying-in hospitals where antisepsis is not used—luckily, now the rare exception—an epidemic of abortion or premature labor might occur from septic infection during pregnancy.

## CLINICAL HISTORY OF ABORTION AND MISCARRIAGE.

It will be noticed that premature labor is not referred to. Its course, management, complications, and after-treatment may be considered in the description of labor at term, from which it does not materially differ. The treatment of the premature infant may, however, be briefly referred to. The indications to be met in these cases are to supply artificial heat—for the production of heat by the life-processes in the infant is insufficient to sustain life—and to secure the entrance of small quantities of the infant's natural food, human milk, into the stomach at regular and frequent intervals, without the exposure necessary in frequent nursing by the mother and without the exertion of muscular force demanded to extract the milk from the breast, of which very often the infant is incapable. These requirements have only recently been adequately met by the use of incubators, such as those designed by Crede[1] and Tarnier,[2] and b a system of forced feeding proposed by Tarnier. Crede's incubator ha been in use for more than twenty years in the Leipsic Maternity. I it have been placed 678 premature children, weighing, with few exceptions, less than 5¼ pounds each. Of this number, only 18 per cent died. In the Maternité at Paris, since 1881, 151 premature childre have been treated in Tarnier's incubator, and of this number 30 pe cent. died, but the children all weighed less than 4 pounds. Tarnier apparatus is complicated, and will probably not come into general us Crede's appliance is readily made and easily handled. It is simply bath-tub made of copper, with double walls, the space between them

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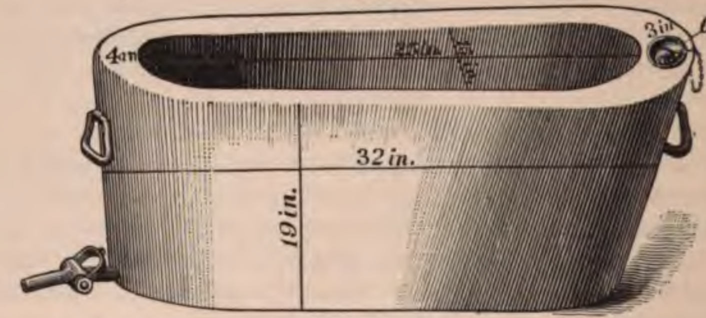
[1] Mundé: "Case of Pregnancy in One Horn of a Double Uterus, with Successive Miscarriages," *Am. Journ. Obstet.*, 1887, pp. 337, 346.

[2] See Doléris: *Nouvelles Arch. d'Obstét. et de Gynéc.*, 1886, p. 318.

[3] Schroeder: *Geburtshülfe*, 8te Aufl., 1884, p. 460.

[4] *Recherches sur l'Avortement épizootique des Vaches*, Broch., Paris, 1886.

Fig. 189.



A Crede's Incubator in Use in the Maternity Hospital of Philadelphia.

contain hot water. According to Crede's directions, the space betwe the walls is to be filled every four hours with water at a temperatu of 122° Fahr. This maintains a temperature within the tub varyi from 107½ to 99½° Fahr. The tub is filled half full of cotton woo the child, undressed, is placed upon the cotton wool with some absorbent cotton about its genitals which is to be renewed from time to time the tub is then filled up with cotton, a space being left for the child face, that it may breathe. Instead of the daily bath given to health infants, a premature child should be rubbed once a day with warm oi In the Maternity Hospital of Philadelphia these children are fed b passing every hour a soft gum cathether into the stomach, throug which is slowly injected, by means of an ordinary glass ear-syringe, little more than a drachm of human milk at about the body-heat. Th catheter and syringe are kept scrupulously clean, and the milk is pump from the breast of the child's mother or some other healthy woman. Th treatment, with us, gives excellent results.

The Clinical History and Frequency of Abortion.—It almost impossible to arrive at a correct estimate of the frequency abortion. So many women lose an impregnated ovum at an early period of its development, when they are not conscious even of being pregnant; so many others fail to seek medical advice for an abortion uncomplicated by hemorrhage or decomposition of retained secundines,—that almost all the estimates of the relative frequency of abortion and labor at term place the figure for the former too low. Hegar[1] says that one abortion will occur to every eight or ten labors at term, but the estimate of Guillemot and Devilliers,[2] of one abortion to every four or five pregnancies, is doubtless more correct—an opinion in which Tarnier coincides. Priestley[3] found that 400 women, among whom there had been 2325 pregnancies, gave a return of 542 abortions, or about one abortion to every four pregnancies. The main clinical phenomena of abortion are—(1) hemorrhage, (2) pain, and (3) the expulsion of more or less characteristic portions of an impregnated ovum. But these signs are rarely all manifested in a typical manner in every case. Pain may be absent, hemorrhage not excessive, and the whole ovum when cast off so small that it escapes unnoticed among the clots of blood that are discharged from the uterus. Such cases occur shortly after conception, and often pass for disordered menstruation, while the fact that pregnancy had begun is not suspected.

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[1] *Arch. f. Gyn.*, Bd. xxiv. S. 128.

[2] Auvard: "De la Couveuse pour Enfants," *Arch de Tocolog.*, 1883, p. 577.

The duration of abortion varies in different cases to an extraordinary degree. The French speak of an "*avortement instantané*," and Cazeaux gives an example in a woman who fell upon her buttocks, and on rising found on her linen considerable blood and a six weeks' ovum. In some cases the expulsion of the ovum may occupy about the time consumed in a normal labor, but very frequently the process is a much slower one. Days, and even weeks, may be required for the uterus to get rid of its contents if left unaided to nature, and it is not rare for a fragment of the placenta or a portion of the uterine decidua to remain behind indefinitely, firmly attached to the uterine wall and often continuing to grow and develop, constituting within the uterus a true pathological new formation.[4] Of the two symptoms, pain and hemorrhage, the former is in early abortions usually the subordinate one. The hemorrhage is not often excessive, but can become alarming. The blood is expelled not in a steady flow, but from time to time as coagula. When the uterus finally throws off its contents, the appearance of the substance expelled differs as the ovum is cast off entire with its shaggy chorional coat, or surrounded by the decidua, which is often much thickened; as the embryo, enveloped by its amnion, is extruded without the decidua and chorion, or as the embryo, its delicate umbilical cord being ruptured, is expelled alone. The appearance of the embryo will of course differ with the different periods of pregnancy: if still enclosed in its amniotic sac, a thin-walled, transparent vesicle may be found floating in the blood or imbedded in a clot, and within the sac the embryo is seen floating in the liquor amnii. In other cases the ovum will resemble a ball of flesh, which on being opened discloses an embryo confined within a sac with very thick walls, composed mainly of grea hypertrophied decidua. Or, again, the substance expelled from t uterus may be a fleshy mass, the deciduous membrane, in shape a c of the uterine cavity, which on section reveals within itself an emp cavity. The embryo in these cases has either died and been absorbe or else has been previously cast off unnoticed in the bloody discharge

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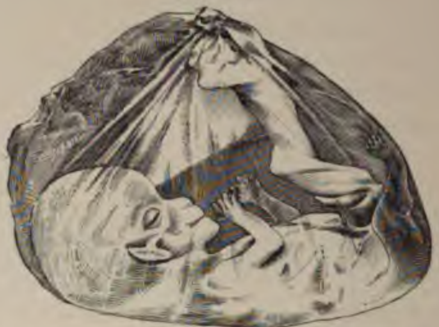
[1] "Beiträge zur Pathologie des Eies," *Monatsch. f. Geburtsh.*, Supplem., Bd. xxxi. S. 34.

[2] Tarnier et Budin: *op. cit.*, p. 474.

[3] *Pathology of Intra-uterine Death*, London, 1887, p. 8.

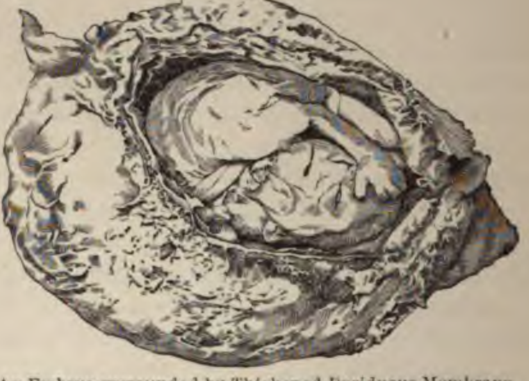
[4] A condition described under the names "placental polyp" and "polypoid hæmatomata," but more correctly as "deciduoma."

FIG. 190.



An Embryo in its Amniotic Sac (from the Medical Museum of the University of Pennsylvania).

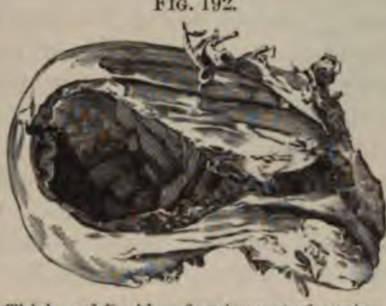
FIG. 191.



An Embryo surrounded by Thickened Deciduous Membrane.

If the ovum proper is cast off entire—that is, with its chorion covering intact, without adherent shreds of deciduous membrane—it presents an appearance quite characteristic, especially if floated in water: the chorional villi show to the best advantage, giving the ovum very much the appearance, except for its color, of a chestnut bur.

FIG. 192.

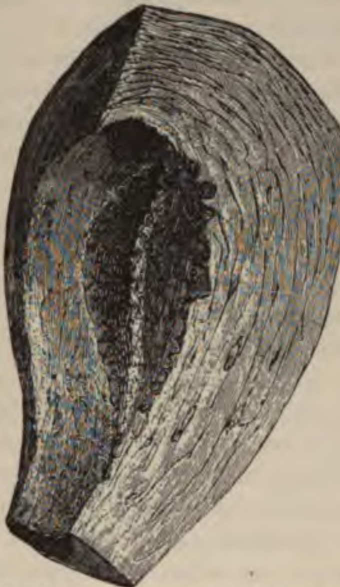


Thickened Decidua, forming cast of uterine cavity.

Most frequently it is the embryo alone, or at most the ovum, in whole or in part, covered often by the ovular decidua, that is cast off, while the uterine decidua remains behind within the uterus.

Dūhrssen,[1] from a rich experience in the service of the Charité in Berlin, says that "the retention of portions of the decidua vera is not the exception, but the rule;" and Tarnier says that "ordinarily the uterine decidua remains adherent to the uterus." The retention of this membrane after abortion cannot be regarded with indifference, for the uterine mucous membrane in the early part of pregnancy, greatly hypertrophied and thickened, before it has undergone the physiological atrophy that begins in the third month, is very different from the delicate membrane which lines the uterus at term. This thickened uterine decidua, suddenly cut off from the greater part of its blood-supply by contraction of the uterine wall, becomes a mass of dead animal flesh within the uterus, and soon begins to putrefy, or else portions of the decidua attract an increased blood-supply, retain their original development, or even increase in size, forming new growths within the uterus which give rise to frequent and alarming hemorrhages.

FIG. 193.



A Section through the Median Line of the Placental Site, showing greatly hypertrophied placental decidua (specimen in the writer's possession, taken from a woman seven days post-partum).

It is this complication of abortion that often makes the prognosis uncertain, and is perhaps the main factor in raising the mortality after abortion to a point almost as high as that of childbirth at term. In New York City, between the years

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[1] "Zur Pathologie und Therapie des Abortus," *Arch. f. Gyn.*, Bd. xxxi. H. 2.

1867 and 1875, inclusive, 197 deaths were reported as a result of abortion—a number doubtless far short of the truth. In the Rotunda Hospital of Dublin, during the mastership of Dr. Johnston, 234 abortions occurred, with but 1 death, and that from heart disease.[1] But of 120 cases treated in the clinic and polyclinic of the Charité in Berlin, 2 died.[2] Of 82 abortions in the Obstetrical and Gynecological Institute of Florence,[3] 5 resulted fatally to the women—a death-rate of 6 per per cent. In the Charité at Paris (1883–86) there were 57 cases of abortion without a death; and in the Maternité, 153 cases with 1 death (Tarnier). Hospital statistics, however, as to the death-rate after abortion are unsatisfactory. The reliable records of some large outdoor dispensary service would tend to throw light upon the matter. The thesis of Lechler, containing statistics of this kind, already referred to in a foot-note, is, unfortunately, inaccessible to me. But whatever might be the exact result of the statistics of large numbers of cases in general practice, it is certain that every abortion entails a certain amount of risk upon a woman, and therefore the mode of treatment that will best avoid the two chief dangers of abortion, hemorrhage and septicæmia, must be a subject of anxious consideration for every physician.

DIAGNOSIS.—It may be necessary in cases of suspected abortion to determine the existence of pregnancy: that fact being established, it becomes necessary to distinguish between threatened abortion, inevitable abortion, and an abortion partially or wholly accomplished.

*The Diagnosis of Threatened Abortion.*—If a patient should present a history of suppression of the menses, perhaps for only one period; if it could be learned that she had been exposed to the possibility of impregnation; if there were, in a word, the signs of early pregnancy, and a hemorrhage should occur from the uterus, associated with more or less pain,—the supposition that an abortion was threatened would be certainly justified. Irregularities in menstruation, the suppression of the function from causes other than pregnancy, and its re-establishment by a profuse flow, accompanied by pain, might well arouse a suspicion of abortion. In these cases, however, the signs of pregnancy are wanting, and it is claimed that the blood comes away in a stream, and not by clots, and that the os will not be found patulous. This is by no means true of every case, however, and if the symptoms should be due to an effort of the uterus to expel a polypoid tumor, the case may closely resemble one of abortion that the diagnosis will only be made after the expulsion of the uterine contents or the dilatation of the os. In cases of doubt the diagnosis had better rest on abortion and the treatment be adapted to this idea.

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[1] Lusk's *Obstetrics*, 1886, p. 313.

[2] Dührssen: *loc. cit.* This same author mentions the statistics of 520 cases of abortion collected in the inaugural thesis of Lechler (Berlin). Half of these, treated active interference, showed 4 deaths—3 from intercurrent affections, 1 the result abortion.

[3] Fasola: "82 aborti nel triennio 1883–85," *Annali di Ostet. e Gynecol.*, March, 18

*The Diagnosis of Inevitable Abortion.*—It is always desirable to determine when a threatened abortion becomes inevitable, for when its prevention is no longer possible the treatment should be radically altered. Unfortunately, however, the signs which usually denote an unavoidable expulsion of the ovum are not always to be depended upon. If there is persistent hemorrhage, abortion will usually occur, but even in spite of a bleeding which may continue for a considerable time or return at intervals during the whole duration of pregnancy, the case may go on to term. If the cervix becomes markedly softened and the os dilates, the ovum will ordinarily be cast off; and yet the os has dilated sufficiently to admit two fingers, but has again retracted, and pregnancy has pursued its course. If portions of the uterine contents should be expelled, it would seem that abortion was surely inevitable; but Playfair, Charpentier, and Doléris have reported cases in which pieces of decidua were expelled from the uterus without the interruption of pregnancy. In Playfair's case four or five fragments of decidua, each as large as a fifty-cent piece, were cast off in the third month of pregnancy as a result of the introduction of a sound into the uterus; but the woman went on to term. The only two conditions which can be said to render the abortion almost inevitable are the rupture of the membranes and the death of the embryo; but even were it possible to ascertain with certainty during the early months of pregnancy that the membranes were ruptured or that the embryo was dead, cases might be recalled where the liquor amnii was resupplied after puncture of the pregnant uterus with the trocar (Chiara), or many other cases might be collected of the retention of an ovum after the death of the embryo for months or an indefinite number of years. If, however, the hemorrhage is persistent; if the os dilates; if there is felt presenting within the os a cystic tumor, the ovum;[1] if the pain is considerable; and, above all, if portions of the ovum are expelled,—the abortion may be pronounced inevitable. Tarnier[2] calls attention to another sign which he believes to be valuable as indicating an unavoidable abortion. This is the effacement of the rather acute angle formed anteriorly between the neck and body of a pregnant uterus. The disappearance of this angle indicates a contraction of the longitudinal fibres of the uterus and a descent of the ovum.

*The Diagnosis of an Abortion Partially or Wholly Accomplished.*—It is always important to determine in a case diagnosticated as one of abortion whether a part or the whole of the uterine contents has been expelled; or, where there is doubt as to the nature of the case, the detection of characteristic portions of an ovum in the discharge will at once disclose the fact that a pregnancy has been interrupted. To make the diagnosis, then, of an abortion partially or wholly effected it is necessary to carefully examine everything discharged from the uterus: the clots should be floated in water, and should be carefully teased apart, when often, if the case is one of abortion, an embryo, either alone or more or less enveloped by its membranes, may be discovered, leaving, of course, no doubt as to the case. But frequently the embryo and ovum are so small that they are lost in the comparatively great volume of blood that surrounds them, or the discharges are removed from the patient and are not preserved. In such cases an internal digital examination will ordinarily serve to determine the true nature of the case. The os will usually be found patulous; the finger, passing into the cavity of the uterus, will detect shreds of deciduous membrane more or less closely attached to the uterine wall, and often a placenta, still adherent, or some portions of the fœtal membranes, may be plainly made out. If the abortion has been wholly accomplished—that is, if all the uterine contents, including the hypertrophied decidua, have been completely expelled—the uterus will be firmly contracted, the os retracted, and a digital examination of the uterine cavity will be difficult or impossible. Here the diagnosis must depend upon the history of the case, upon the examination of the discharge, upon the enlarged uterus—which does not at once return to its normal size—upon the lochial discharge, and upon the establishment of the milk secretion. This last phenomenon is all the more marked the later the date of pregnancy at which abortion or miscarriage occurs, and is more evident in multiparæ than in primiparæ; but Budin has observed a young girl in whom the menses were suppressed for only twenty days, and then returned as a profuse flow, who exhibited shortly afterward all the signs of commencing lactation.

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[1] It is well to bear in mind, in this connection, the possibility of the cervical pregnancy of Rokitansky, already referred to, of which several cases have been reported.

[2] Tarnier and Cazeaux, vol. i. p. 574.

In other cases the disappearance of all the presumptive signs of pregnancy, which had been before well marked, would justify the opinion that an abortion had occurred; but it might denote nothing more than the death of the embryo, which can be retained within the uterus for varying periods of time, and when cast off may give rise to unjust suspicions as to the woman's moral character. Thus, if a woman whose husband may have been absent many months should expel from her uterus an embryo corresponding perhaps to the second month of intra-uterine life, it by no means invariably follows that she has been unfaithful.[1]

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[1] Tarnier et Budin: *op. cit.*, p. 499.

Finally, if in the early months of pregnancy there is hemorrhage and a discharge of deciduous membrane, it would be well, while making the digital examination, to feel on either side of the uterus for a tumor that might indicate a tubal pregnancy.

*Miscarriage.*—Much that has been said of abortion is applicable to miscarriage as well, but by the time pregnancy has reached a period from the fourth to the seventh month, it is not likely that the condition will be overlooked, so that one great difficulty in the diagnosis of abortion, the doubt as to the existence of pregnancy, does not, as a rule, obtain in cases of miscarriage. In these cases too it is easier to detect those two accidents which make the expulsion of the ovum almost inevitable—rupture of the membranes and the death of the fœtus—for the liquor amnii has reached such a quantity that its escape would almost always attract attention, while the death of the fœtus, followed by a cessation of fœtal movements and of growth in the uterus, by a disappearance of the reflex and psychical disturbances characteristic of pregnancy, and also perhaps by the appearance of the milk secretion, is not likely to pass unnoticed. The pain associated with miscarriage is greater than in abortion, and assumes the type of labor-pains; during the periodic contractions of the uterus the organ can be felt through the abdominal walls becoming hard and firm, and relaxing again as the pain passes off. The expulsion of the ovum resembles also a labor at term, as the fœtus usually is first expelled and the membranes and placenta follow after. As pregnancy advances this sequence becomes more and more the rule, but occasionally the ovum is cast off entire even at a late period of pregnancy. I have seen such an occurrence between the sixth and seventh months, and it has actually been reported to have occurred at term.

Miscarriage is chiefly distinguished from abortion by the formation of the placenta, and from premature labor by the fact that this organ is quite adherent to the uterine wall, and often fails to become detached after the expulsion of the fœtus, remaining wholly or in part adherent to the uterus, preventing proper contraction of the uterine muscle, and consequently giving rise to serious hemorrhages. And, moreover, those portions of the placenta that are detached from the uterus, if allowed to remain undisturbed in the uterine cavity, will almost surely putrefy, giving rise in time to pyæmia or sapræmia.

PROGNOSIS OF ABORTION AND MISCARRIAGE.—The prognosis as regards the product of conception need not be considered, for its destruction is inevitable. Statistics have been already given showing that every abortion or miscarriage entails a certain amount of risk upon a woman. The hemorrhage, if rarely so great as to be immediately fatal, may by its persistence so weaken a woman that she quickly succumbs if attacked by any intercurrent affection, or the syncope produced by loss of blood may favor the formation of heart-clot. The retention of masses of decidua or of the placenta is often followed by the decomposition of these substances in utero, with fatal septicæmia as a result. Tetanus is another complication post-abortum, which will, in rare cases, help to raise the mortality of abortion.[1] Criminal abortions, with the additional risks of traumatism from the unskilful use of instruments and the probability of infection from unclean hands and implements, would show probably a very high rate of mortality if it were possible to collect accurate statistics; which, for obvious reasons, it is impossible to do. With, however, a thorough appreciation of the sources from which danger springs, and by the adoption of a treatment which will remove the possible causes of perilous complications, the death-rate of abortion should be reduced to the minimum.

TREATMENT.—If a pregnant woman presents any of the conditions which a physician's experience or knowledge teaches him may lead to the premature interruption of pregnancy, the treatment of these conditions will constitute the preventive treatment of abortion. Much has been said upon this subject when the diseases of the embryo and fœtus and of the ovum were under consideration. The proper conduct to pursue in the other complications of pregnancy just described may be briefly indicated.

In cases of irritable uterus the woman must be jealously guarded against any nervous shock, undue physical exertion, errors in diet, sexual intercourse—anything, in a word, that would furnish the uterus an excuse for throwing off its contents. In exaggerated cases of this condition prolonged rest in bed, especially at the time corresponding to the menstrual periods or perhaps for the whole duration of pregnancy, may be necessary to secure the birth of a mature infant. If the pregnant uterus is displaced downward or backward, it must be restored to its proper position, and be kept in place by a suitable pessary until its increasing size prevents it again descending or falling backward. If there should be uncontrollable vomiting or coughing, these conditions must be treated according to well-known principles. Asthma, which in some cases will determine a premature interruption of pregnancy, is best treated by change of climate.[2] In general muscular spasms, as in eclampsia, cholæmia, chorea, epilepsy, hysteria, and tetany, the convulsions must be combated by appropriate remedies. The infectious and febrile diseases of pregnancy must be managed on general principles without special regard to the danger of abortion, which is often unavoidable. Chronic metritis and endometritis, fibro-myomata of the uterus, lacerated cervix, perimetritis and cellulitis, disease of a tube or an ovary must be treated before impregnation occurs. If, however, in spite of every precaution, the signs of threatened abortion manifest themselves, the treatment resolves itself into—(1) the treatment of threatened abortion, (2) the treatment (if necessary) of inevitable abortion, and (3) the treatment of the woman post-abortum.

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[1] For 21 cases of tetanus after abortion, see Bennington: *British Gyn. Journ.*, 188[illegible]

[2] See note by Harris to Playfair's *Midwifery*, p. 243.

*The Treatment of Threatened Abortion.*—The two main principles of the treatment adopted to avert a threatened abortion should be perfect rest and the administration of drugs that will diminish nervous sensibility and weaken muscular action. The first can only be secured in bed in a perfectly supine position: the room should be darkened and kept quiet, that the rest may be mental as well as physical. The second object of the treatment can be accomplished by giving opium, bromide of potassium, and chloral. Opium enjoys a well-deserved reputation in these cases; many instances might be cited of its beneficent working. It may be administered by the mouth as laudanum, hypodermatically as morphia, or by the rectum; it seems to be the custom in France to inject laudanum into the rectum—a clumsy method of accomplishing what is better effected by our suppositories. Women on the verge of abortion display usually a remarkable tolerance of opium, and to be effective the dose must often be large: as much as a drachm or more of laudanum has been given within twenty-four hours without ill effect, but of course the patient must in such cases be carefully observed. With the opium it is often of advantage to combine moderate doses of chloral and bromide of potassium. Viburnum prunifolium[1] has of late years been much vaunted as almost a specific in the prevention of abortion, and its use has become very general throughout this country. The verdict in regard to this drug is, on the whole, favorable: Lusk speaks well of it; in England it has been tried by Campbell[2] and Napier,[3] who both recommend it; and its employment seems to have spread even to Russia.[4] It may be given, in the form of a fluid extract, in teaspoonful doses.[5]

*Treatment of Inevitable Abortion.*—As soon as all hope of arresting a threatened abortion is destroyed by the appearance of signs pointing to the unavoidable expulsion of the uterine contents, the treatment must be radically altered. Absolute rest is no longer necessary, while the administration of drugs that diminish sensibility and weaken muscular action is positively harmful, for it prolongs a process which in the interests of the patient were best completed as speedily as possible. But in many cases the woman will linger on, perhaps for days, before the greater part of the uterine contents is expelled, and it may be weeks before she is rid of the thickened decidua, which usually remains behind, or of the adherent placenta, which is often retained in the uterus after the escape of the embryo and the rest of the ovum; and all this time there may be recurring hemorrhages of an alarming character or a constant dribbling of blood, and the lochial discharge becomes abundant, and is perhaps ill-smelling. Now, in such a case, the question naturally arises as to the advisability of interference, either early in the progress of the case, in order to bring it to a speedy termination and to thoroughly clear the uterine cavity of substances that might give rise to future trouble, or at least when the hemorrhages become alarming and the discharges offensive. This question receives different answers from authorities equally entitled to respectful attention.

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[1] Jenks: "Viburnum Prunifolium," *Tr. Am. Gyn. Soc.*, vol. i. p. 130.

[2] *Br. Med. Journ.*, 1886, i. p. 391.

[3] *Ibid.*, p. 489.

[4] Reference in *Index Med.*, 1887, Lvov.

[5] Negri has recently recommended large doses of asafœtida in cases where there had previously been a tendency to abort or to give birth to dead children. Great virtue is claimed for this drug, but it has not yet been given a sufficient trial to warrant an expression of opinion in regard to it.

If the hemorrhage is severe before the os is at all dilated or any portion of the ovum discharged, there is no difference of opinion as to the necessity of controlling the bleeding. This is best effected by a vaginal tampon of baked cotton,[1] made up into balls about the size of a walnut, packed closely in the vaginal vault and in front of the cervix until the vagina is filled in its upper third. A Sims speculum will facilitate the introduction of the tampons. Braun's colpeurynter, which is recommended so highly by its inventor for this purpose, has not, and probably will not, find general acceptance. If the woman is so anæmic that the loss of even a small quantity of blood is of moment, it would be of advantage often to tampon the cervical canal, or, better still, the whole uterine cavity, employing for this purpose either little balls of iodoformed cotton, as Vulliet advises, or strips of iodoform gauze, as Dührssen[2] does in these cases. Vulliet's method has done me good service in controlling severe hemorrhages from the body of the uterus in cancerous disease of that organ, and would probably be found very useful in the hemorrhage of abortions, especially in the early months of pregnancy. The vaginal tampon should be removed after six or eight hours, and replaced by a fresh one if necessary, but often, as the first one is removed, along with it will come the ovum or fœtus, and the immediate symptoms may in great part subside. But the uterus may not yet be empty; in the early months the large mass of deciduous membrane has almost certainly remained behind in the uterine cavity; later, the placenta will frequently be retained. Here it is that there is much difference of opinion as to the proper course to pursue. Whet now to treat the case expectantly until serious symptoms develop, or to remove at once the substances in the uterus which may give rise to future complications, is a problem that must frequently confront every practitioner. In France the more conservative course is almost universally adopted. Tarnier quite recently speaks strongly in favor of avoiding any interference even if the whole placenta is known to be in the uterus; he insists that the uterus should be allowed time to expel the foreign substance in the course of nature, but that in the mean time antiseptic injections should be systematically employed: if, however, alarming hemorrhage appears or the discharge becomes foul, more active measures are counselled. Tarnier points to the statistics of the Charité and the Maternité, in which he saw 46 cases of retained placentæ after abortion, with only 1 death, and that from pneumonia; but the statistics of the hospital in Florence already referred to, in which pretty much the same plan seems to be pursued as that advocated by Tarnier, show a death-rate after abortion of 6 per cent. Guéniot was for some time the only prominent dissenter from the general practice in France, but recently he has been joined by Doléris,[1] who recommends active interference in retention of the placenta, but counsels a conservative course when the membranes are retained. In Germany the same difference of opinion may be met with in regard to the treatment of inevitable abortion, but the majority lean to a more active course. Schroeder[2] says that although the abortion must not be hastened until there is some dilatation of the os and until the ovum is pretty well separated from the uterus, then the uterine contents can often, in the early months at least, be pressed out by Hoening's method, squeezing the uterus between two fingers in the vaginal vault and those of the other hand on the abdomen. If any portion of the ovum should remain behind, it must, says this author, be invariably removed, even should the cervix have to be split on both sides to reach it. If the retained substance is the hypertrophied decidua of early pregnancy, Schroeder advises the use of the sharp curette to remove it. Fehling[3] and Schwarz[4] are also warm advocates of an active treatment. Braun[5] rather deprecates the employment of instruments in these cases, but advises the use of the finger, whenever possible, to remove the ovum. Dohrn,[6] on the other hand, carries the expectant plan of treatment to its farthest limits, and Winckel attempts no active interference.[7]

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[1] Cotton baked in an oven till it becomes a little singed and well sterilized. use of antiseptic cotton is scarcely advisable, for the quantity required for an effici tampon is so large that the danger from absorption of the germicide with which i impregnated cannot be overlooked.

[2] *Loc. cit.*

In this country the views of Mundé are well known. "The future safety of the patient," says this authority, "demands that the secundines should be at once removed after the expulsion of the fœtus in every case in which such removal can be accomplished without force sufficient to injure the woman." Parvin, whose opinion must always command respect, recommends, on the other hand, non-interference with the cavity of the uterus in abortion unless at some later period hemorrhage occur or septicæmia is threatened.

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[1] *Nouvelles Archives d'Obstet.*, 1886, p. 318.

[2] *Geburtshülfe*, S. 482.

[3] *Archiv f. Gyn.*, Bd. xiii. S. 222.

[4] *Samml. klinischer Vorträge.*

[5] *Lehrbuch der Gesammten Gynäk.*, 2te Aufl. S. 614.

[6] *Samml. klin. Vortr.*, 42.

[7] Practice observed by the writer while volunteer interne in the Frauenklinik at Munich.

Now, in determining this question in regard to the treatment of inevitable abortion, an answer to the following questions is desirable: Is the retention of decidua, fœtal membranes, or placenta after abortion fraught with any danger to a woman? and, Is the immediate removal of the secundines after abortion necessarily a violent or dangerous procedure? Cases are reported, it is true, in which the retention of the placenta was followed by no immediate symptoms; but will any one say that under such circumstances a woman is healthy and free from danger? The following case, abstracted from Tarnier and Cazeaux, is instructive in this connection, for Tarnier, be it recollected, is one of the foremost advocates of the expectant treatment: the italics in the quotation are mine: "During the first five days the patient did very well, but on the sixth *I thought I detected a slight odor in the lochia*, and at three o'clock in the afternoon a violent chill came on which lasted an hour. . . . This unfortunate lady died on the tenth day. At the post-mortem examination we found the uterine tissue softened and *its cavity filled by the putrefied and still adherent placenta*." Note that on the sixth day there was a mere suspicion of a putrid odor to the discharge, and yet at that very time this woman's life was probably doomed.

The question as to the danger of active interference after abortion can only be answered by those who have adopted this plan of treatment in a skilful and judicious manner. Dührssen[1] has lately reported 150 cases of abortion treated by a thorough and immediate clearing out of the uterine cavity, with only 2 deaths, and these in no manner attributable to the treatment adopted. I have used the curette in many cases post-partum et abortum, and have never seen the slightest ill effects from it; on the contrary, the treatment proved invariably beneficial. It must be acknowledged, however, that in the hands of general practitioners, unaccustomed to gynecological manœuvres, the curette in the puerperal uterus may prove a dangerous instrument. A most distressing case has recently occurred in Berlin,[2] where a practitioner caused the death of a patient by perforating her uterus with a curette after an abortion, in consequence of which this unfortunate physician was sentenced to imprisonment. There will be many, therefore, who will be indisposed to resort to instrumental interference after abortion; and, moreover, in a choice of the treatment to be adopted much depends upon the temperament of the physician well as upon the circumstances of the case. Consequently, in a work of this kind it is fairer to give a sketch of both plans of treatment.

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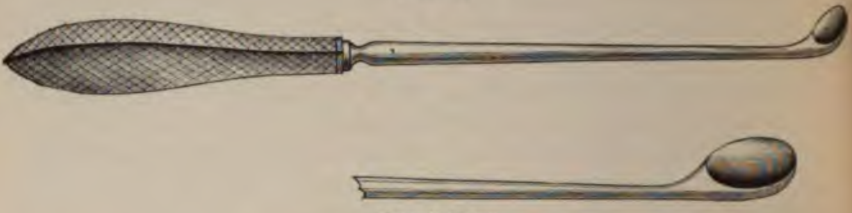
[1] *Loc. cit.*

[2] *Deutsche med. Wochenschr.*, 1886, 28,

*Expectant Treatment.*—When an abortion becomes inevitable, ergot may be substituted for the drugs that have been employed to inhibit muscular action; if there is much bleeding, tampons are to be used in the manner already indicated, and removed from time to time until the ovum is expelled, or else so well separated from the uterine wall that it may be gently expressed or easily extracted by the fingers. The greatest care must be exercised to avoid rupture of the membranes, for this will probably lead to the retention of a portion of the ovum, whereas the expulsion of the ovum *en bloc* is particularly desirable in cases managed after this fashion. If a part of the embryo or its appendages should remain behind in the uterus, the woman is to be kept quiet in bed, small doses of ergot are to be administered, and the vagina and, if possible, the uterine cavity are to be kept aseptic by injections of some effective germicide, preferably bichloride of mercury in solution. The folly of neglecting this precaution until the substance in utero begins to putrefy is shown by the case already quoted. If, in spite of every precaution, the discharge becomes foul, or if hemorrhages occur, all are now agreed that the uterine cavity is to be cleared out. The manner of doing this will be indicated later.

*Active Treatment.*—The first step of this plan of treatment resembles that already described. The tampon is used to control bleeding, and as soon as the dilatation of the os is sufficiently advanced to admit a finger, efforts are made, in early abortions, to turn out the ovum by sweeping the fingers around it, and then extracting it, with the finger crooked behind it like a hook; or Hoening's method of expression may be tried. The proposition of Dührssen to treat the ovum before he third month like a polypoid tumor, and so soon as the os is slightly ilated to introduce a curette and incontinently clear out the uterine ntents, is, to the writer's mind, not a bad one. The ovum being holly or in part expelled, everything left behind in the uterine cavy, whether thickened decidua or placental tissue, is to be extracted. arious means have been proposed for accomplishing this purpose. or an adherent placenta nothing is better, in the writer's opinion, an the finger, which can be made to reach the fundus, the patient ing anæsthetized if necessary, by pressing the uterus down from ove through the abdominal walls. By the finger the placenta is led off from the uterine wall, and afterward easily extracted. Often much force is necessary to do this that the use of an unyielding and ensible instrument is not advisable. To clear out the thickened idua, which almost invariably remains behind in early abortions, hing is so good as a curette, of which many varieties have been proposed for this purpose. Mundé's instrument demands a widely-opened os, and is more effective as an extractor of substances loose within the uterus than as an instrument designed to separate membrane or placenta adherent to the uterine wall. Simon's spoon has been very satisfactory to me when the os is small and the uterine cavity is not too large. For the uterus post-partum or after miscarriages I have an instrument somewhat resembling Mundé's in shape, but with a distinctly scraping edge.[1] Dührssen has demonstrated that the decidua removed from the uterus in this manner is not rudely torn off, but is separated in a natural manner in the cellular layer. If the os is so retracted that neither a finger nor an instrument can be introduced, the introduction of Hegar's graduated hard-rubber cervical dilators will obviate the difficulty.

FIG. 194.



Simon's Spoon.

Fig. 195.

A Cervical Bougie.

After the uterine cavity is cleared out, it should be disinfected by a gentle stream of antiseptic solution introduced preferably through a Bozeman's catheter.

*The After-treatment of Abortion.*—If an active treatment has been pursued, the after-treatment will be very simple, for the lochial discharge in these cases is slight and the involution of the uterus rapid. Until this latter condition is perfected the woman, of course, should be confined to bed. The after-treatment when an expectant plan has been pursued has already been indicated. Should septicæmia develop, it is to be managed on the same principles that govern the treatment of this condition after delivery at term.

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[1] Described in the *Am. Journ. Obstet.*, Dec., 1887.

# THE PHYSIOLOGY OF PREGNANCY.

BY WILLIAM WRIGHT JAGGARD, A. M., M. D.,

CHICAGO, ILL.

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PREGNANCY inaugurates a series of structural changes, with corresponding modifications of function, in every organ and tissue of the body. In the study of the natural history of this process, as it affects the maternal organism, it is convenient to consider, first, the local changes; and second, the general changes.

## I. CHANGES IN THE GENITALIA AND NEIGHBORING ORGANS.

### CHANGES IN THE UTERUS.

Of all the changes in the maternal organism caused by pregnancy, the first in point of time, the most noticeable, and the most important occur in the uterus. Many years ago Swammerdam[1] christened this organ the *miraculum naturæ*, and modern science fully indorses the apophthegm.

The normal relations of the non-gravid womb are modified under the influence of the nutritive energy imparted by the fecundated ovum as to structure, volume, weight, form, position, direction, topography, and function.

*Structure.*—The increase in the size of the uterus is due largely to modifications of its musculature. The original length of the muscular fibres is 0.045–0.09 mm., with a breadth of 0.0074–0.015 mm. They grow rapidly, attaining from seven to eleven times their original length and from two to five times their original breadth (Kölliker). At the same time, new non-striated fibres are developed from embryonic muscle-cells stored up especially in the inner layers of the uterine wall. It has been asserted that when this store of embryonal elements has once been used up, either pregnancy does not occur again or it is not completed (Spiegelberg). The hypertrophy of the muscular elements continues throughout pregnancy, while the hyperplasia is apparently limited to the first five months. The sparse connective tissue between the muscular fibres undergoes proliferation, becomes more succulent, and toward the end of pregnancy shows fibrillæ.

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[1] Joh. Swammerdam, 1672: *Miraculum naturæ s. muliebris fabrica.*

The arrangement of the muscular fasciculi in the gravid womb—obviously a difficult study—is still the subject of controversy. Hélie,[1] after twelve years' investigation, concludes that three layers or coats are distinctly separable into an external, a middle, and an internal lamella.

1. The external layer, composed of alternating planes of longitudinal and transverse planes, covers the corpus and fundus like a veil from the cervical junction in front to a lower point posteriorly. As this layer approaches the fundus its lateral fibres curve outward and are prolonged along the round ligaments, tubes, ovarian and broad ligaments, enveloping these structures in a sort of muscular drapery. This layer is intimately adherent to the peritoneum.

2. The middle or vascular layer, constituting the bulk of the musculature of the corpus, is composed of fasciculi of variable size which cross each other in all directions. Through this intricate, arciform arrangement of the fasciculi the veins, reduced to the intima, run in true contractile channels. The arteries, however, are separated from the encircling muscular bands by connective tissue, so that they are enabled to glide in the rings. The functional importance of this structural peculiarity is great, since it affords a satisfactory explanation of the mechanism by which hemorrhage after labor is in part prevented.

3. The internal layer. On the inner aspect of the anterior and posterior uterine walls a triangular stratum of muscular fibres is visible, whose base corresponds to a line drawn transversely between the tubal ostia, and whose apex descends to the os internum. Between the sides of these triangles muscular fasciculi run transversely, constituting rings. Orbicular bands are arranged around the tubal ostia and internal os immediately beneath the lamella just described.

The musculature of the cervix is derived exclusively from the external and internal layers, and is composed chiefly of transversely annular fibres.

While it is possible to dissect off the three layers just mentioned, it must be borne in mind that fibres pass from one stratum to another, binding all of them together into one hollow muscle.

The researches of Kreitzer,[2] Luschka,[3] and Henle[4] correspond in general with Hélie's observations. Von Hoffmann[5] describes the arrangement of the lamellæ in accordance with the view that the uterine muscular substance is derived by a transformation of the musculature of the tubal endings. The important investigations of C. Ruge[1] throw much light upon the subject. In the pregnant uterus at term the muscular lamellæ lie upon each other in strata which, having their origin in the peritoneum and being inserted in the decidua, pursue a course, from upward and outward, downward and inward. The individual lamellæ, superimposed upon each other like tiles, are mutually bound together by bands of muscular fibres which pass obliquely from one principal stratum to the plane immediately beneath, so that when the bundles are somewhat stretched apart in dissection, they form long drawn-out rhomboid figures.

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[1] *Recherches sur la Disposition des Fibres musculaires de l' Uterus dévellopé par la Grosses*
Paris, 1864.

[2] *Petersburger med. Zeitschrift*, 1871, p. 113.

[3] *Die Anatomie des Menschlichen Beckens*, Tübingen, 1864.

[4] *Eingeweidelehre*, 1873, p. 476.

[5] "Morpholog. Untersuch. über die Muskul. des Gebärmutterkörpers," *Zeitschrif*
*Geburtsh. und Frauenkrankheiten*, 1876, p. 448.

FIG. 196.

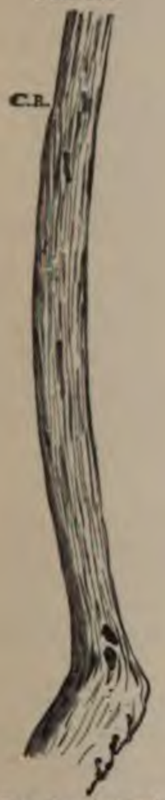

FIG. 197.

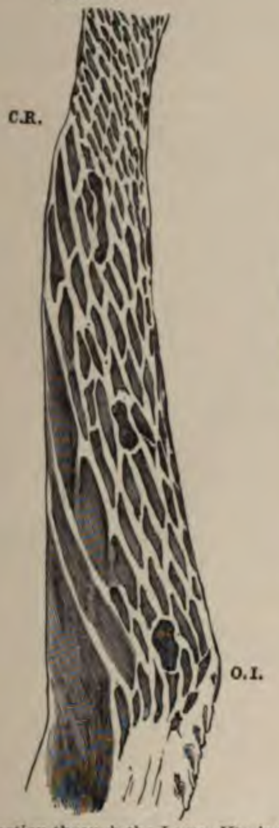

FIG. 198.

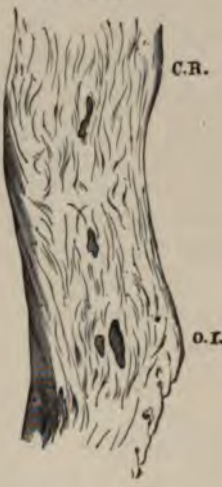

FIG. 196.—Longitudinal Section through the Lower Uterine Segment of a Parturient Uterus.
FIG. 197.—The Same Section, with individual muscle-lamellæ drawn apart.
FIG. 198.—Longitudinal Section of same Character, with indication of the shortened musculature.
O. I., orificium internum; C. R., contraction-ring (C. Ruge, Schroeder).

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[1] *Archiv f. Gynäk.*, xv. p. 262; *Zeitschrift. f. Geburtsh. u. Gynäk.*, v. p. 149; Keuller, *Diss. Inaug.*, Berlin, 1880.

Bayer's[1] observations constitute the most recent important contributions to the literature of the subject. After a laborious study extending through a considerable period of time, Bayer draws the following conclusions:

1. "The internal longitudinal fibres of the tubes form the largest part of the submucous muscular layer, while their external longitudinal layer forms a part of the external fasciculi of the uterus. The circular layer of the oviducts, on the other hand, assists in the formation of the middle coat.

2. "The chief mass of the musculature of the lower pole of the corpus and of the cervix is developed from the *retractors*. The lower portion of the posterior wall of the corpus in its greatest thickness, a thinner and higher zone of the anterior wall, the entire posterior and lateral wall of the cervix, as well as the anterior lip and the lower portion of the cervix immediately above, have this origin.

3. "The rest of the uterine musculature is derived from the radiating fibres of the gubernaculum of Hunter—the chief mass of the posterior wall of the corpus downward to the fibres of the retractors and the muscle-bundles surrounding in different strata the tubal angles of the womb from the ovarian ligaments, the external layer of the anterior wall of the corpus and lower portion of the cervix, and the entire supravaginal portion, from the round ligament. The middle layer of the fundus is formed from both ligaments in common.

"It will thus be seen that a division of the entire musculature into three or more definite strata is not feasible, since the arrangement of the fibre-masses is diverse in different parts of the uterus. Its construction can only be understood by examining the individual portions of the uterus separately.

"In a word, the entire uterus contains almost everywhere sphincter fibres. The entire cervix ought to be comprehended as a sort of sphincter; however, its sphincter action is opposed to the influence of the remaining systems of fibres. During the expansion of the uterus this sphincter is broken, since the anterior segments of the ring of the retractors are drawn apart and elevated with the increase in breadth of the leaves of the round ligament; the superior boundary of the sphincter will always lie at the upper end of the closed cervical canal. In the lower section of the cervix the sphincter action continues even after the expansion of the uterus, and is only removed by the pressure of the descending contents of the uterus, because it depends here upon the elasticity of the masses of connective tissue."

The practical importance of adequate knowledge of the arrangement of the uterine musculature during pregnancy may not be at once apparent

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[1] "Zur Physiologischen und Pathologischen Morphologie der Gebärmutter," p. *Gynäkologische Klinik*, Strassburg, 1885.

rent. Brief reflection upon the modern theory of labor, however, must convince the most casual reader of its utility.

The transformation of the decidua of menstruation into the decidua of pregnancy is fully discussed in another article. It may not be amiss, however, to mention, in passing, a new hypothesis of menstruation, or rather the revival of an old one, which if demonstrated will modify materially the views now current as to the structural and functional changes in the uterine mucous membrane during gestation. Arthur W. Johnstone[1] has arrived at the conclusion "that in the ordinary acceptation of the term the endometrium, above the internal os, is not a 'mucous membrane,' but belongs to the so-called 'adenoid' tissues, and that menstruation is for it exactly what the lymph-stream is to the lymph-gland or the blood-current to the spleen." The "menstrual organ" consists of a single layer of epithelial cells which slips into every reduplication of the glandular canals, thus giving a protecting coat to the soft protoplasmic tissue beneath, the essential element. When the epithelium is stripped off, the endometrium presents to view a tissue suggestive of the lymph-glands as regards structure and function. Haller and Hunter regarded menstruation as a secretion. Ercolani hinted at this view. Dewees and Hodge vigorously upheld a doctrine not dissimilar to the hypothesis now proposed by Johnstone.

The arteries increase in length, circumference, and number. They become more tortuous—a fact which proves their increase in length is not due to diminution in the number of flexures (Jacquemier). The branches are much larger than the trunks, and are found in greatest abundance near the placental site. They terminate directly in the parenchyma of the after-birth (utero-placental arteries) and adjacent veins, or, in other regions, in capillaries. Their course becomes especially spiral or corkscrew-like as they approach the placenta—an arrangement which facilitates the closure of the canals by uterine contractions. The arteries are surrounded by a thin lamella of connective tissue, so that they glide in the rings of the uterine muscular fibres. The uterine artery, a branch of the anterior trunk of the internal iliac, and the ovarian, a branch from the aorta of both sides, anastomose, and form a vast network of vessels situated nearer to the peritoneal than to the mucous coat. One of the most important anastomoses, a branch from the uterine artery to the ovarian, runs nearly parallel to the epigastric and attains a size larger than the radial. Glénard designates this vessel the puerperal artery, and erroneously regards it as the seat of the uterine souffle.

The ovarian vein increases to the size of the internal or external iliac, measuring 3–4 mm. in diameter (Jacquemier). The uterine plexus of veins is converted into a system of enormous sinuses located in the middle muscular layer and beneath the placental site. These sinuses communicate freely with each other, and at term are large enough to admit the tip of the little finger. The veins are valveless, but the true contractile channels of the middle muscular tunic through which they run, reduced to the intima, perform the functions of valves. The utero-placental veins have been described when the structure of the placenta was under consideration.

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[1] "The Menstrual Organ," *The British Gynæcological Journal*, part vii., 1886, p. 292.

The uterine lymphatic system undergoes hypertrophic and hyperplastic changes in all form-elements analogous in kind and degree to those of the blood-vessels. In the light of recent discoveries the whole intra-uterine expanse may be viewed as one vast lymph-sinus (Spiegelberg, Johnstone). Originating in the lymph-spaces surrounding the utricular glands and blood-vessels, the lymphatic tubes, frequently the size of a goose-quill, pass through the muscularis, communicate with the lymph lacunæ and spaces of the region, and are collected together in a plexus beneath the peritoneum, especially over the fundus and along the sides of the uterus. The lymphatics of the corpus and fundus join the lumbar glands, while those of the cervix communicate with the pelvic glands (Leopold). These changes are of functional importance in the evolution and involution of the womb, and explain in part the disposition to the absorption of septic matter of the pregnant, parturient, and puerperal organ.

Once the subject of controversy, it has now been demonstrated that there is a new formation of nervous tissue in the pregnant uterus. The cervical ganglion becomes enormously enlarged, increasing in size fourfold until it attains a length of 5 cm. and a breadth of 3.79 cm. (Frankenhäuser). The uterine nerves grow in length and circumference, the increase in thickness being largely due, however, to the proliferation of the neurilemma. They terminate in the nuclei of the muscular fibre-cells or in the submucous ganglia. Reimann[1] has pointed out the physiological necessity for ganglia in the uterine walls, while their actual presence in the inner muscular tunic has been demonstrated by another observer.[2]

The sensibility of the uterus is probably not altered during pregnancy, and remains limited to the general perception of external stimuli. The endometrium evinces the highest degree of sensibility; the vaginal portion the least.

*Volume, Capacity, and Weight.*—Corresponding to the textural changes in the gravid uterus, an enormous increase in volume, capacity, and weight ensues, the resultant of very great eccentric hypertrophy and passive distension by the fecundated ovum. During the first half of gestation the increase in these relations is due to true eccentric hypertrophy, since the ovum is too small to mechanically distend the uterus. Moreover, the analogous changes occur in the uterus during the same period in cases of ectopic gestation. Then, too, in cases of pregnancy in the double uterus, the empty horn undergoes hypertrophy and hyperplasia. Passive distension by the ovum, however, is an important factor during the second half of pregnancy, since the muscular parietes grow progressively thinner, until at term the thickness of the fundus is only 1 cm., equal to, or even less than, the thickness of the virgin fundus. Even at the end of the fifth month Schroeder[1] has observed the thickness of the fundus reduced to 3–5 mm.

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[1] *Arch. f. Gyn.*, Bd. ii. Heft 1, p. 97, 1871.

[2] Spiegelberg, *Mon. f. Geb.*, xxiv. pp. 12, 13.

At term the uterus, 6.5 cm. long in the virgin state, measures 35 cm. in length, 24 cm. in breadth, 23 cm. in depth (Spiegelberg). Sir James Y. Simpson gives the following measurements: length, 12–15 inches; breadth, 9–10 inches; thickness, 6–8 inches.

Farre[2] and Tanner have constructed the following table, showing the rate of increase in the size of the uterus according to the months of gestation:

| | Length. | | Breadth. | |
|---|---|---|---|---|
| | Inches. | Cm. | Inches. | Cm. |
| End of 3 months . . . . . . . . | 4½–5 | 11.3–12.6 | 4 | 10.1 |
| " 4 " . . . . . . . . | 5½–6 | 13.8–15.1 | 5 | 12.6 |
| " 5 " . . . . . . . . | 6–7 | 15.1–17.6 | 5½ | 13.9 |
| " 6 " . . . . . . . . | 8-9 | 20.1–22.6 | 6½ | 16.4 |
| " 7 " . . . . . . . . | 10 | 25.2 | 7½ | 18.9 |
| " 8 " . . . . . . . . | 11 | 27.7 | 8 | 20.2 |
| " 9 " . . . . . . . . | 12 | 30.2 | 9 | 22.7 |

Sir James Y. Simpson estimates the surface of the unimpregnated uterus at 5–6 square inches, with a capacity of 1 cubic inch; at term its surface measures 350 square inches, with a capacity of 400 cubic inches. Krause states that the capacity is increased 519 times.

The weight of the uterus at term varies from 900 to 1200 grams. Morean has observed a specimen weighing 1700 grams. Assuming the weight of the non-gravid nulliparous organ to be 42 grams, the parous womb 55 grams, it is obvious that the weight of the gravid uterus at term is twenty-one to twenty-four times as great as in the unimpregnated state (Meckel).

*Form.*—During the first three months the flattened, pyriform shape of the uterus undergoes slight alterations. There is a relative increase in the antero-posterior diameter, so that the contour of the organ has been aptly compared to that of a fig. The fundus and upper portion of the corpus—corresponding to the site of the ovum—gradually begin to grow in the direction of the transverse and antero-posterior axes, so that during the second trimester the uterus assumes the form of a short ovoid or a flattened spheroid, with the cervix at the most dependent part but little changed. In consequence of the inclination forward of the top-heavy fundus, the yielding nature of the anterior abdominal parietes, and the rigid, unyielding character of the support of the posterior uterine wall, the angle at the junction of the cervix with the corpus is rendered more acute and a physiological anteflexion is produced. During the third trimester growth in the direction of the longitudinal axis preponderates, and the uterus acquires an ovoid shape, with the cervix corresponding to the smaller end. The form of the uterus, however, as remarked by Spiegelberg, is not constant, especially during the last three months. Its contour depends upon a variety of conditions, such as the posture of the woman, the volume of the uterine contents, the presentation of the fœtus, the tension of the organ, and, finally, upon its primitive formation. The form of the uterus is accordingly more variable, as a rule, in multiparæ than in primiparæ.

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[1] *Lehrb. d. Geburtshülfe*, p. 88, Bonn, 1884.

[2] "The Uterus and its Appendages," *Todd's Cyclop. of Anat. and Physiol.*, p. 645.

*Position.*—During the early part of the first trimester the uterus sinks in the pelvic cavity as the result of increased weight augmented by the pressure of the intestinal mass upon the enlarged area of the fundus. This descent causes a slight flattening of the hypogastrium, of some significance in the diagnosis of pregnancy. The phenomenon, as pointed out by Spiegelberg, Tarnier, and others, is by no means constant. Toward the end of the first trimester the uterus, no longer capable of accommodation within the pelvic cavity, begins to rise above the brim into the cavity of the abdomen. At the end of the third month the fundus is about one centimeter above the pubes. It reaches or passes slightly above the plane of the umbilicus during the second trimester, and distends the epigastrium at the thirty-eighth week, the vaginal portion frequently being above the plane of the inlet as early as the twenty-eighth week. About the last fortnight, in primiparæ, the womb descends, owing to the engagement of the head and lower uterine segment within the pelvic cavity.

*Direction.*—The uterus in passing up into the abdominal cavity is inclined forward against the less resistant anterior abdominal parietes by the lumbar spine, following in its growth the general direction of the axis of the pelvic inlet. In eight (Cazeaux) out of ten cases it deviates to the right of the median line, and is slightly rotated on its longitudinal axis, so that the left lateral surface is brought somewhat forward. This right lateral obliquity and axial rotation has been ascribed to a great variety of causes: the relatively frequent insertion of the placenta on the right side of the uterus (Levret); the presence of the descending colon and sigmoid flexure, often filled with scybala (Desormeaux, Dohrn); the habit of lying upon the right side; the ative shortness and greater development of the right round ligament (Boivin); the mode of the evolution of the uterus (Pajot, Spiegelberg).

These changes in direction are of considerable practical importance. The uterine bruit is usually heard most distinctly over the left lateral surface of the uterus. The latero-version may interfere with the engagement and descent of the presenting part, requiring a change in the posture of the woman. Then in the performance of the Cæsarean section it is necessary to correct these changes in order to bring the incisions through the abdominal wall and the uterus into proper relation.

*Topographical Relations.*—The configuration and relations of the uterus in the abdominal cavity are subject to numerous and important changes, since it is a soft, relaxed sac, with only relative fixation at its inferior extremity. In the erect posture the fundus falls forward against the anterior abdominal wall, bulging it outward, since the centre of gravity is far in front of the symphysis. The antero-posterior diameter of the abdominal cavity, on a level with the fifth lumbar vertebra, now measures about two-thirds of the thickness of the entire body (Spiegelberg). In the horizontal decubitus the uterus rests upon the spine, with an increase in the longitudinal and diminution in the antero-posterior axes.

The topographical relations of the pregnant uterus have been accurately studied within a recent period by the comparison of plane frozen sections of women dying during gestation. Waldeyer's[1] observations are of especial interest. He describes the median sagittal section of the uterus of a woman dying within a few days of term as a regular oval, with the larger end corresponding to the fundus. The anterior convex surface rests below on the anterior half of the pelvis, the empty bladder lying behind the symphysis. The lower three-fourths of this anterior convex surface is applied to the abdominal wall from the symphysis to a distance of one hand's breadth above the navel. The fundus, on a level with the second lumbar vertebra, corresponding to B. S. Schultze's observation, is covered by coils of the small intestine and transverse portion of the duodenum, which separate it from the pancreas, stomach, transverse colon, and liver. The posterior surface is concave, corresponding to the convexity of the curve of the lumbar spine. It is in relation, from above downward, with the abdominal aorta, left common iliac vein, fifth lumbar vertebra, and sigmoid flexure.

Waldeyer's investigations agree in the main with the results arrived at by Braune,[2] Schroeder,[3] and Chiari.[4]

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[1] *Medianschnitt einer Hochswangeren, etc.*, Bonn, 1886, p. 25.

[2] *Die Lage des Uterus und Fötus am Ende der Schwangerschaft*, Leipsic, 1872.

[3] *Der Schwangere und Kreissende Uterus*, Bonn, 1886.

[4] *Ueber die Topographischen Verhältnisse des Genitales einer Inter Partum Verstorbenen Primipara*, Wien, 1885.

All four observers unite in the opinion that the intestines are push above and to the sides of the uterus, that viscus pressing more or le directly upon the great abdominal vessels and ureters. This fact is obvious significance in connection with the pressure theory of Bright disease during pregnancy. Then the location of the intestines at great a distance from the anterior convexity of the uterus indicat that when the bladder is empty there is little danger of woundi these organs or of their escape in the primary incision of Cæsare section. Their functions are not directly influenced by uterine pr sure. The respiratory movements of the diaphragm, on the ot hand, are limited, in some degree, especially toward the end of g tation.

*Function.*—The chief change in uterine function consists, of cour in the transformation of the menstrual organ into an adequate recept ulum for the development and expulsion of the fœtus. There is lit doubt but that menstruation is suspended with the commencement pregnancy. If ovulation did occur throughout gestation, we shou expect to find, instead of one, several corpora lutea vera. Extend observation has failed to reveal more than one corpus luteum veru after the birth of a single child (Gusserow) or to show recently ru tured ovisacs (Virchow). Moreover, the researches of Slavjansky ha demonstrated that in so-called pseudo-menstruation the changes in t ovaries and endometrium bear no resemblance whatever to the stru tural modifications of menstruation. All periodical discharges of blo from the uterus during pregnancy are, accordingly, due to some path logical condition of the cervix, decidua, chorion, or placenta.

While pregnancy creates no new property (Pajot), the irritabilit contractility, and retractility of the uterine musculature are ve greatly augmented. These modifications will be discussed in conne tion with the diagnosis of pregnancy and the physiology of labor

## Behavior of the Cervix Uteri during Pregnancy.

Conflicting views as to the changes which occur in the cervix ut during pregnancy and labor have been urged from the latter part the eighteenth century up to the present day. Within the last fift years investigations have assumed a more exact character, and posi opinions are expressed with a greater degree of diffidence as the re more particularly, of the anatomical researches of Braune and the num ous studies of Bandl. The literature of the subject is so enormous it is only possible, in the space at our command, to allude to a few the more important monographs in order to sketch the general outli of our present knowledge upon this important topic.

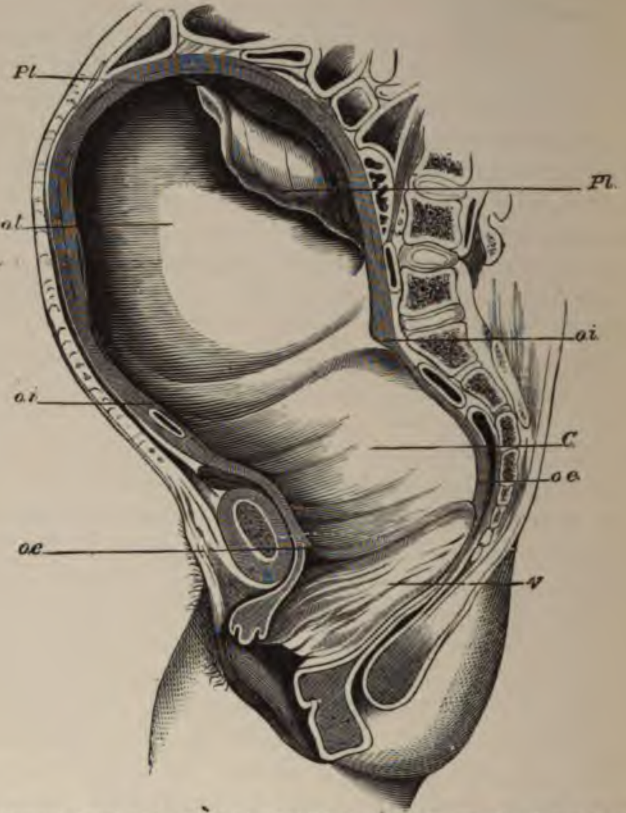
The apparent shortening and ultimate partial or complete disapp ance of the vaginal portion of the cervix during pregnancy and la are such sensible and constant phenomena that their occurrence is not questioned. The causation of the phenomena, however, has been productive of almost infinite controversy—a fact which justifies the conviction that the problem remains unsolved.

*Old Theory.*—Roederer (1753) and Stein, Sr., his pupil, observed and described clearly and distinctly the apparent shortening and ultimate partial or complete disappearance of the vaginal portion during pregnancy and labor. They promulgated the dogma, explanatory of the phenomena, that as pregnancy advances the cervical canal is dilated from above downward, and is greatly diminished in length in consequence of its being gradually drawn up so as to form part of the general uterine cavity, so that in the latter months only a small vaginal segment remains and the presenting part approaches the os externum. Levret, Baudelocque, and Velpeau taught this doctrine.

*Modern Theory.*—Certain of the older anatomists—R. de Graaf (1671), Verheyen (1710), and Weitbrecht (1750)—advocated the belief that the cervix uteri persisted in an unchanged condition until the end of pregnancy. Stoltz (1826), probably influenced by the teachings of the older anatomists, opposed the doctrine of Roederer and Stein, Sr., and asserted that the shortening and ultimate partial or complete disappearance of the cervix were only apparent, not actual, and depended upon a fusiform dilatation of the cervical canal, with the approximation of the external and internal ora. This theory, with slight modifications, has been upheld by Kilian (1839), Birnbaum (1841), Boivin, Scanzoni, Cazeaux, Dubois, Depaul, Duncan (1859–63), Taylor (1862), Holst (1865), Spiegelberg (1865), Peter Mueller (1868), Lott (1872), Lusk (1873), Chantreuil, Arthur Farre, Pajot, and others.

In the midst of this confusion of opinions Wilhelm Braune (1872) published his memorable monograph, *The Position of the Uterus and Foetus at the End of Pregnancy*. The monograph was illustrated by plates made from plane frozen sections of the body of a woman thirty-five years old who died at the commencement of labor. Braune describes the internal os as situated above the inlet, and noticeable from the lumen of a large vein with a smaller one beside it, the only veins which were found patent in the walls of the uterus. "In the empty cavity of the uterus the internal os appeared as a freely-projecting semicircle, 4 cm. above the symphysis and 2 cm. above the promontory of the sacrum. The external os, which was completely dilated, appeared as a small projection." The dimensions of the cervix at the end of pregnancy, according to Braune, are—length of anterior wall of the cervical canal, 11 cm.; of the posterior wall, 10 cm.; circumference, 30 cm.; average thickness of the wall, 5 cm.; capacity 165 cm. (Lahs).

FIG. 199.



Section of Genital Canal after Removal of Child, showing the canalization of the cervix and the canal of Braune (Braune): *Pl.*, Placenta; *o. t.*, tubal orifice; *o. i.*, os internum; *C*, cervix; *o. e.*, os externum; *v.*, vagina.

Bandl[1] (1875–76) published two remarkable monographs in general confirmation of the old theory, and in sharp contrast with the doctrine of P. Mueller[2]—a paradigm of the theory of Stoltz. Mueller asserted from the examinations and measurements of one hundred pregnant women that the cervix—irrespective of the position of the presenting part, whether above or below the pelvic inlet—remained in an unchanged condition until the end of pregnancy, and in many cases even during the beginning of labor. "The finger after passing the os externum must traverse a shorter (minimum, ¾ inch) or a longer (maximum, 1¼ inches) distance before arriving at the membranes. At the place at which the membranes are touched a sphincter muscle reacts

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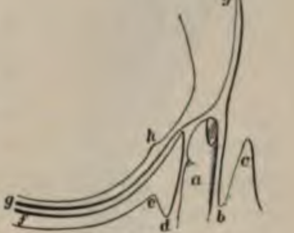
[1] *Ueber die Rupture der Gebärmutter*, Wien, 1875; *Ueber das Verhalten des Uter* *Cervix in der Schwangerschaft und Während der Geburt.*, Stuttgart, 1876.

[2] *Untersuchungen über die Verkürzung der Vaginal Portion in den letzten Monate* *Gravidität*, Würzburg, 1868.

oundary-line, and if the finger is introduced still higher the walls e uterus are found relaxed, and absolutely no trace of an internal n be found." The cervix of Müller, accordingly, is a little thin-d tube, 2–3 cm. in length, bounded below by the os externum, by a constriction termed by Carl Braun in 1857 the *isthmus*, the *al os* by Müller, but more generally known as the *ring of Müller.* l called attention to the facts that the cervix of Müller did not spond with the virgin cervix of Luschka Henle, which has a length of 3.5 cm. proportionate volume, and that it was ceivable that this little thin-walled, le-like process could be so distended as eive the head of the child and still be ble of functional activity, as shown in ne's plate. Bandl's theory, briefly stated, that at a variable period prior to labor or eight weeks—the presenting part gment of the egg presses upon the in-l os of Braune, and a dimple is pro-d. By degrees the dimple grows larger, nternal os is dilated, the presenting part gment of the egg descends into the pel-while the softened muscular elements of the cervix and the upper on of the vagina are transferred to the lower uterine segment; the lua covering the lower segment of the egg cannot keep pace with rowth of the lower uterine segment, is lacerated, and the egg comes contact with the lower segment of the uterus deprived in part of ithelial covering. The ring of Müller is seen at the bottom of ower uterine segment as a displaceable ring of mucous membrane *artefact* of nature, as Fritsch terms it, without sphincter func-

FIG. 200.



Vaginal Portion of a Primipara, with head deep down in the pelvis (Müller): *b*, posterior lip; *c*, posterior fornix; *d*, anterior lip; *e*, anterior fornix; *g*, membranes; *h*, head.

a median sagittal section of the uterus at term three distinct por-are recognized: 1, corpus uteri; 2, lower uterine segment; 3, us membrane. 1. The corpus uteri is differentiated from the uterine segment by the thickness of its walls, the arrangement s muscular elements in accord with Luschka's investigations, ably firmer consistence, the decidua large in amount and firmly rent to the mucosa. 2. The lower uterine segment is more or less ble in the cadaver according as the egg or presenting part is more s descended into the pelvic cavity, and according as it has exerted fluence for a longer or shorter period upon the already-formed r uterine segment. It is differentiated from the corpus uteri by the ess of its walls, the arrangement of its muscular elements, remark-softer consistence, the decidua small in amount and loosely adhe-

Fig. 201.

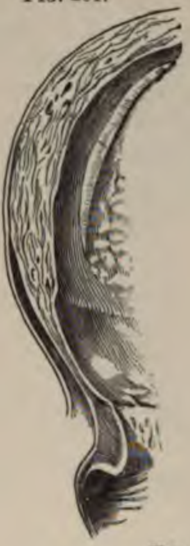


Fig. 202.

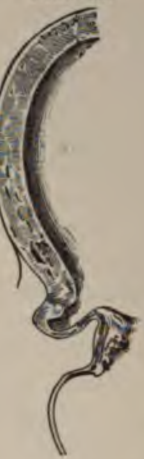


Fig. 203.

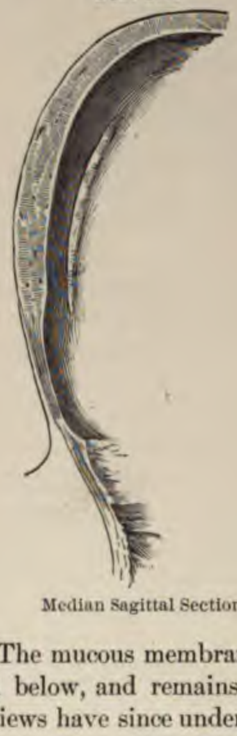
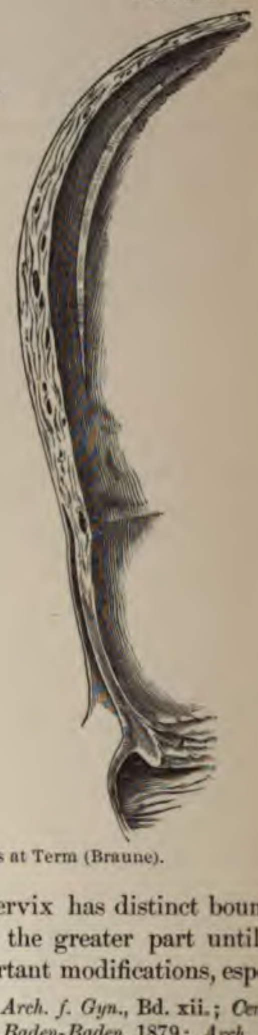


Fig. 204.



Median Sagittal Sections of the Uterus at Term (Braune).

rent. 3. The mucous membrane of the cervix has distinct bound above and below, and remains intact for the greater part until t Bandl's[1] views have since undergone important modifications, espec

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[1] *Vortrag. a. d. Münchener Naturforschervers*, 1877; *Arch. f. Gyn.*, Bd. xii.; *Centr* *Gyn.*, 1877, p. 177; *Vortr. a. d. Naturforschervers in Baden-Baden*, 1879; *Arch. f.* Bd. xv.

with reference to the cervical mucosa, as the result of the microscopical investigations of Küstner and Marchand. His recent utterances are to the effect that in first labors the mucous membrane of the dilated portion of the cervix—the lower uterine segment—becomes torn or stripped off, and subsequently a new membrane is formed upon the denuded surface not distinguishable from that of the corpus, which in future pregnancies is capable of forming a decidua. The differentiation between corpus and cervix—lower uterine segment—is accordingly marked by the muscular wedge, vein, peritoneal insertion, and entrance of arteries, as illustrated in Braune's plate, but not by any change in the mucous membrane. The lower uterine segment is the neck of the uterus, and the former term is superfluous.

The enunciation of Bandl's views has been followed by a lively controversy, which seems to have degenerated into a polemic between Berlin and Vienna. Schroeder designated the internal os of Braune—erroneously termed the ring of Bandl—the contraction-ring, and regarded the lower uterine segment as derived from the corpus uteri. Thus, Hofmeier[1] draws the following conclusions respecting the anatomical and physiological relations of the lower uterine segment:

1. The cervix, characterized by its anatomical structure and mucous membrane, remains intact as a closed or almost closed canal until the beginning of labor. Slight appearances of dilatation in its upper portion are always conditioned upon antecedent uterine contractions.

2. The "lower uterine segment" forms by its anatomical structure and its mucous membrane a well-characterized portion of the uterine body, and differs essentially in both particulars from the cervix of the pregnant as well as of the puerperal uterus. It differs, however, not immaterially, in gross appearance and on minute inspection, from the remaining portion of the uterus, and on this account well deserves a distinct designation.

3. The physiological behavior of the lower uterine segment during labor is essentially passive as opposed to the remaining portion of the uterus, which is sharply contrasted with it by contractions. Since this difference is pronounced and especially palpable only after lively uterine contractions, and since it is apparent as a ring upon the introduction of the hand within the uterine cavity, as well as by external palpation, the designation of this boundary as "contraction-ring" seems to correspond to the actual relations.

An important contribution to this vexed question has been added by Bayer in the monograph to which allusion has already been made.

Bayer's conclusions are:

1. The mucous membrane of the lower uterine segment produces a

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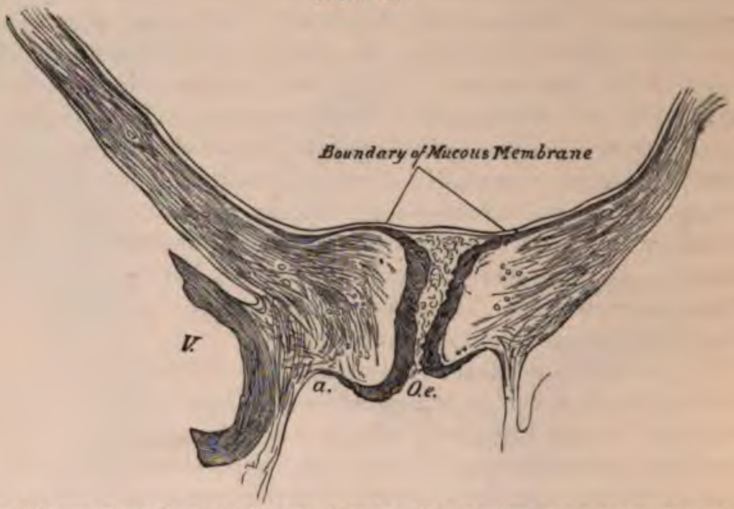
[1] Schroeder: *Der Schwangere und Kreissende Uterus*, Bonn, 1886; *Das untere Uterinsegment in Anatomischer und Physiologischer Beziehung*, p. 70.

FIG. 205.



Gravid Uterus, Tenth Month (Hofmeier): V. vesica; O. e, os externum; a, anterior vaginal fornix.

true decidua, which passes gradually into the mucous membrane of the cervix. This decidua is distinguished by its extraordinary thinness and the longitudinal stretching of its meshes in the ampullary stratum. Genuine cervical mucous membrane extends up the posterior wall of the lower uterine segment to a variable distance. It is impossible to distinguish the site of the internal os by any differentiation of the mucous membrane.

2. It would be better to limit the use of the term "internal os" to the non-pregnant organ or to the uterus in the early months of pregnancy, when the cervix is intact and the mucous-membrane boundary distinct—in a word, to the period during which an internal os really does exist.

3. The perfectly-developed lower uterine segment of the gravid uterus corresponds to the supravaginal portion of the cervix of the virgin organ, from the internal os downward.

While the object of this note is to present in an impartial manner the most recent views, and not to enter into their critical discussion, still it may be permitted to say, in passing, that the weight of evidence, as collected from internal sources—the nature and amount of material as well as the methods of investigation—seems to us to be very much in favor of Bandl's modified theory. Perhaps it would be as well to accept for the time being a sort of compromise definition, like that of Bayer,[1] for example: "The lower uterine segment is a transient appearance, the formation of which commences in the second half of pregnancy, reaches its highest development during labor, and gradually disappears during the puerperium. From a clinical point of view the conception is perfectly definite: it is that portion of the uterus which in normal cases at term envelops the presenting part completely or almost completely. During labor it is especially thinned out, distended, paralyzed, while the thick, contractile muscle-mass of the corpus lies above. The *ensemble* of the phenomena of contraction, with their expulsive effect upon the uterine contents, occur above it, while in it only the appearances of distension during labor and of relaxation afterward are apparent."

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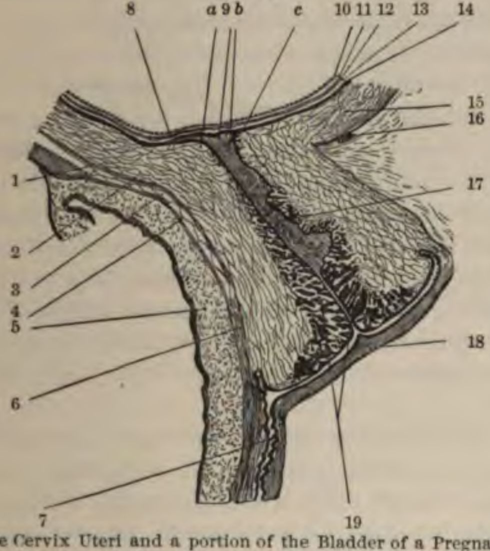
[1] *Resultate über das untere Segment., loc. cit.*, p. 398.

While the changes in connection with the formation of the lower uterine segment are usually demonstrable during life and immediately after death, as in Chiari's[1] recent drawings, still it must be admitted that in certain cases these alterations are so slightly developed as to escape careful observation. Thus, Waldeyer[2] was unable to find any trace of Schroeder's contraction-ring or of the lower uterine segment in the frozen section of a woman dying within a few days of term; and he expresses the opinion that the cervix persisted in a relatively unchanged condition throughout the pregnancy.

FIG. 206.



Section through the Cervix Uteri and a portion of the Bladder of a Pregnant Woman, magnified (Waldeyer): 1, peritoneum; 2, reduplication of the connective tissue; 3, cervico-vesical space; 4, connective tissue; 5, bladder; 6, connective tissue between vagina and bladder; 7, lumen of the vagina; 8, from *a* to *b*, and from *b* to *c*, the boundary-line of the cervix; 9, internal os; 10, amnion epithelium; 11, amnion; 12, intermediate layer; 13, chorion; 14, cellular layer and uterine mucosa; 15, muscul. uteri; 16, vein; 17, cervical mucosa; 18, vagina; 19, cervical glands.

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[1] *Ueber die Topographischen Verhältnisse des Genitales einer Inter Partum verstorbenen Primipara*, Wien, 1885.

[2] *Loc. cit.*, p. 28.

## THE ADNEXA.

The round ligaments grow in length to a degree in correspondence with the ascent of the uterus, and become fourfold thicker. The increase in volume is due chiefly to hypertrophic and hyperplastic changes in the non-striated muscular elements of the upper third, and in the voluntar muscular fibres derived from the deep abdominal muscles for the lowe two-thirds. On account of the relatively greater development of the posterior uterine wall, the origin of these ligaments is apparentl moved forward to a point at the junction of the anterior fifth with the posterior four-fifths of the antero-posterior diameter. Their cours at term is from the navel obliquely downward and outward to th inguinal ring. Owing to the axial rotation of the uterus, the lef round ligament is especially prominent. The utero-sacral ligaments–the uterine retractors (Luschka)—are notably developed. The muscula ture of the uterine ends of the tubes undergoes extraordinary evolution according to the researches of Bayer. The mucous membrane loses it vibratile cilia, and the enlarged lumen is filled with a yellowish-whit viscous fluid containing epithelial débris and fat-globules (Robin). A term the tubes seem to originate no longer in the angles of the uterus but correspond to the middle third of the lateral surfaces. The struc tural alterations in the ovarian ligaments correspond in general wit those in the muscular substance of the tubes. The ovaries increase i volume twofold (Jacquemier), chiefly as the result of the development of the corpus luteum. The ovaries with their ligaments and th tubes are drawn nearer to the body of the uterus and assume a vertica direction.

The pelvic peritoneum covering the uterus is thickened, and grow with the increase of uterine volume until it envelops the supravagina portions of that viscus. The broad ligaments, sharing in the sam changes, are lifted up along with the uterus into the abdominal cavity so that they assume the general direction of the round ligaments. Th connective tissue of the parametrium is augmented in quantity, an becomes more succulent, especially during the last weeks of gestation Relatively large quantities of adipose tissue are deposited in the peripheral fatty layer. J. Veit asserts that the adipose layer of the pelvi connective tissue disappears entirely in pregnancy under the influenc of the serous infiltration.[1] The blood-vessels and lymphatics underg remarkable development.

The round ligaments, ovaries, and tubes can be traced under favo- able conditions by abdominal palpation. The round ligaments, uter- sacral ligaments, and, to a less degree, the broad ligaments, perfo important functions as auxiliary powers during labor. The structural changes in the pelvic connective tissue are of especial interest with respect to the process of puerperal septic infection.

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[1] Hoffmann: *Zeitschr. f. Geb. u. Gyn.*, Bd. i. p. 146; Veit: *Die Anatomie des Beck* Stuttgart, 1887, p. 5.

## THE VAGINA.

Hypertrophic and hyperplastic changes take place in all the morphological constituents of the vagina, analogous in kind, but less in degree, to those in the uterine parietes. The vagina increases in length, and its capacity is augmented by eccentric hypertrophy as well as by the disappearance of the submucous adipose tissue. The venous plexuses encircling the organ are greatly developed. As the result of arterial hyperæmia and passive congestion and the actual increase in the size and number of the vessels, the mucous membrane from the os externum to the genital fissure acquires a bluish-red hue, which has been compared to the color of wine-lees. The thickened, softened, succulent mucous membrane, exceeding in its growth the limits of the eccentric hypertrophy, is thrown up into folds, and frequently causes a protrusion of the anterior vaginal wall into the vulvar canal as a violet-colored swelling, increased by the corpus cavernosum vestibuli. On account of the hypertrophy of the papillary body the finger often detects granular elevations resembling the morbid condition of vaginitis granulosa. The secretions are increased in quantity, become yellowish-white, and contain, besides epithelial cells and pus-corpuscles, large numbers of a species of infusoria (Trichomonas vaginalis), as well as non-pathogenic bacteria. The vaginal portion, usually situated to the left of the median line to a variable extent, seems shortened on account of the swelling of the mucous membrane and the ascent of the uterus. The position of the vagina varies with the position of the uterus.

The vulva shares in the general growth of the pelvic genitalia. The labia majora and minora increase in size, the veins become varicose, secretions are more profuse; the genital fissure gapes in multiparæ, while it appears smaller and retracted in primiparæ.

## THE PELVIC ARTICULATIONS.

Luschka[1] has demonstrated that the sacro-iliac and pubic articulations are true joints, and not amphiarthrodia. This condition is in analogy with the character of these joints in the domestic animals. Strauss and Müller have shown that in these animals the mobility of the pelvic joints has an important function during labor. Lenoir found that in 22 pregnant women between the ages of eighteen and thirty-five years the movements at the sacro-iliac and pubic joints were perfectly evident. If the finger be introduced into the vagina and pressed against the symphysis while the pregnant woman is walking, the elevation of the ramus upon the side of the extremity in motion can be distinctly recognized (Budin). Zaglass described a certain degree of movement in the sacro-iliac joint in the non-pregnant woman. Matthews Duncan has pointed out the exaggeration of this oscillatory movement of the sacrum during pregnancy and parturition. The mobility of the sacro-coccygeal joint is also increased. These alterations in the pelvic articulations occur as the result of elongation of the ligaments and serous infiltration, and are most pronounced during the last weeks of pregnancy and during labor.

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[1] *Die Anatomie des Menschlichen Beckens*, Tübingen, 1864.

## THE MAMMARY GLANDS.

The changes in the mammary glands during pregnancy relate to size, structure, consistence, and function. The increase in the volume of the breasts, frequently noticeable as early as the second month, is progressive, and depends upon hypertrophic and hyperplastic changes in the glandular elements, the deposition of large quantities of fat, and the proliferation of connective tissue between the lobes.

The mammary gland of the embryo, with its simple acini and long excretory ducts, resembles the sebaceous gland in structure. At puberty these lobules branch and increase in size, but the organ reaches complete evolution for the first time during pregnancy. The development of the gland occurs from the periphery toward the centre, and does not affect the organ symmetrically. On palpation it is usually possible to feel irregular nodules and knotty cords, especially in the periphery. The sensibility of the breasts is augmented, and shooting pains, radiating in the direction of the axillæ, are not uncommon. The superficial veins become larger and more distinct, and striæ similar to those on the surface of the abdomen are found in cases of excessive distension of the cutis. The areolæ increase in size, pigmentation is augmented, and the mammillary tubercles are developed. The nipples grow large more erectile, and more sensitive. Upon pressure a few drops of colo trum exude.

## THE NEIGHBORING ORGANS.

The growth and development of the uterus entail disturbances up the neighboring organs—in part due to hyperæmia, in part the resu of mechanical pressure.

The bladder becomes more irritable. Frequent micturition, incon nence, and vesical tenesmus are frequent symptoms during the ea months. These phenomena are caused by the pressure of the gra uterus—limiting the capacity of the bladder in some cases—the stret ing of the neck of the bladder when the uterus ascends into the ca of the abdomen, and the congestion of the vesical mucous memb

During the last weeks of gestation the urethra is sometimes compressed by the presenting part, and retention or the incontinence of retention not infrequently results.

Constipation is apparently the normal condition of the pregnant woman. In many cases this habit has been established prior to gestation. In all cases, however, pressure of the gravid uterus upon the sigmoid flexure, restricted intestinal peristalsis, and the limited action of the abdominal parietes are important etiological factors.

Œdema and varices of the lower extremities, the external genitalia, and the rectum arise from increased intra-abdominal pressure, or, in the early months, from the slowing of the venous current conditioned upon the dilatation of the pelvic veins and the increase in the intra-abdominal pressure. Neuralgias of the lower extremities and abdominal surface are frequently symptomatic of pressure upon the nerve-trunks from the lumbar and sacral plexuses.

## THE ABDOMINAL WALL.

Important changes occur in the musculature of the abdominal walls during pregnancy. A physiological diastasis of the recti is produced during the last three months in the very large majority of cases. Cruveilhier noticed this separation of the two longitudinal muscular bundles at term, and has found it to measure several centimeters.[1] The anatomical cause consists in the stretching of the transversalis, internal and external oblique muscles by the heightened intra-abdominal pressure and the pressure of the growing uterus. The latter factor is directly operative, especially when the woman is erect. Schroeder has found the distance from the ensiform process to the pubic joint 47 cm. when the woman was standing up, and only 40 cm. when she was lying down. The tension, concentrated upon the linea alba, is transferred to the aponeurotic sheaths of the recti, a centripetal attraction is developed, and the inner edges of the muscles separate.

The elasticity of the muscles of the abdominal wall is lessened, and in cases of great distension actual loss of muscle tonus and changes due to pressure-atrophy ensue. The transversalis, external and internal oblique muscles suffer chiefly, while the recti, on account of their long, narrow, thick character, are seldom involved, except in case of extreme distension, as in multiple pregnancy or hydramnion.

The diastasis of the recti becomes very palpable upon the expression of the placenta by the Dublin method. In the operation of laparotomy for large tumors only slight traces of the musculature of the abdominal walls are found to remain, and the linea alba presents the line of greatest tension. Upon the examination of the abdomens of multiparæ about the eighth month—especially in cases of pregnancies succeeding each other at brief intervals—the loss of elasticity, muscle tonus, and the changes due to pressure-atrophy are very plain. The recti are usually well preserved, and stand out in sharp contour from the relaxed lateral aspects of the abdomen. The ileo-costal portions of the quadratus lumborum—the rectus abdominis posticus of Luschka—are also clearly outlined.

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[1] Prochownick: "Die Diastase der Bauchmuskeln im Wochenbett," *Arch. f. Gyn.*, xxvii. Bd. iii. p. 424.

Under favorable conditions the diastasis of the recti disappears, and the other muscles regain their normal tonus within the first two or three weeks of the puerperium. But in cases of original defective development of the abdominal muscles, excessive abdominal distension during gestation, pregnancies succeeding each other at brief intervals, or insufficient care during the puerperium, the diastasis and changes due to pressure-atrophy may persist throughout life, with all their concomitant evils.

The practical import of the changes thus briefly mentioned is obvious. They explain very many cases of the constipation incident to pregnancy. It is a pretty well-established clinical fact that indications for the forceps operation occur more frequently in the United States than on the continent of Europe. This is especially true of the so-called low-forceps operation. The powers of labor seem to be relatively insufficient on account of partial or complete failure of the contractions of the abdominal muscles. This failure may be assumed to be due in part to defective development, in part to the changes incident to pregnancy. Then a strong *a-priori* argument in favor of the use of the obstetric binder during the puerperium may be deduced from the consideration of these changes—an argument greatly strengthened by Prochownick's[1] observations.

The insertions of the abdominal muscles—the internal oblique and the transversalis in particular—into the lower borders of the cartilages of the lower ribs are rendered tense by the growth of the uterus, giving origin at times to considerable pain. This pain is usually most severe on the right side, on account of the dextro-lateral version of the pregnant womb. The symptom is observed most frequently in elderly primiparæ between the eighth and ninth months.

## II. General Changes in the Maternal Organism.

The general changes in the maternal organism, frequently obscure as to genesis, depend largely upon the quantitative and qualitative alterations of the blood and the functional modifications of the nervous system, which, in turn, are greatly influenced by the developing germinal mass in the uterus and the blood-changes. The consideration of these changes constitutes in a large degree a study of the process of nutrition.

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[1] See also Marie Schlee: "Ueber der Dehnung der Bauchwand Während der Schwangerschaft," *Zeitschr. f. Geb. u. Gyn.*, Bd. xiii. p. 1.

While great, and sometimes essential, differences of opinion exist with reference to many alleged facts and the interpretations of such facts, as in other branches of medical science, still, as remarked by Michael Foster, "this agonosphere is merely the envelope of a solid nucleus of acquired truth, which year by year grows larger at the expense of its more fluid and gaseous wrappings." Apart from the utility of the study of the general changes in the maternal organism in the diagnosis, the management, and the comprehension of the morbid conditions of pregnancy, much light is thrown upon many obscure problems in general pathology.

## THE BLOOD, CIRCULATORY APPARATUS, AND BLOOD-GLANDULAR SYSTEM.

The alterations in the blood affect its quantity and quality. The physiological necessity for an increase in the total blood-mass is rendered evident by a number of *a-priori* considerations. The normal quantity of blood would be totally inadequate to supply the increased demand for nutritive material created by the fœtus and its envelopes, the uterus, and the enormously increased circulatory area, without the production of serious anæmia in other organs. Gassner has demonstrated that the increase in body-weight during the last three months of pregnancy is greatly above that accounted for by the uterus and its contents. Of course the blood must participate in this gain. Finally, Spiegelberg[1] and Gescheidlen have determined by experiment that in bitches the total quantity of blood is increased during the second half of pregnancy. We may, accordingly, assume that the total blood-mass in the normal pregnant woman is augmented, especially during the second half of gestation.

The qualitative changes in the blood relate to its water, albumen, corpuscles, fibrin, and iron. The researches of Andral,[2] Gavarret,[2] Delafond,[2] Becquerel,[3] Rodier,[3] Regnauld, and Nasse,[4] indicate that there is an absolute increase in the white corpuscles, fibrin, and water, and an absolute diminution in the red corpuscles and albumen. Spiegelberg and Gescheidlen[5] conclude, from their investigations upon bitches—

1. The total blood-mass increases during pregnancy, but only during the second half.

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[1] The modified Welker method (carbonic oxide-hæmoglobin).

[2] *Annales de Chymie et de Physique*, Juillet, 1842.

[3] "Recherches sur la Composition du Sang," *Gaz. méd. de Paris*, 1844, p. 757.

[4] *Arch. f. Gyn.*, Bd. x. p. 338.

[5] *Ibid.*, Bd. iv. p. 112.

2. The amount of hæmoglobin varies within limits which depend upon the nutrition of the animal.

3. The increase in water, if it occur at all, is insignificant.

Nasse, from experiments on bitches before, during, and after pregnancy, has recently reaffirmed his original proposition, that the amount of hæmoglobin is diminished during pregnancy independently of the nutrition of the animal, and that the amount of water is absolutely increased. Ingerslev,[1] counting the red blood-corpuscles, was unable to detect any marked diminution during pregnancy. Fehling[2] finds an augmentation in the amount of hæmoglobin and an increase of the number of red corpuscles in the blood of the pregnant woman. The most recent contribution to our knowledge upon this subject is contained in the researches of Meyer.[3] Meyer concludes, from the examination of the blood of pregnant and non-pregnant women with v. Fleischl's hæmometer, that—

1. The number of red corpuscles and the amount of hæmoglobin are diminished during pregnancy.

2. After labor the number of red corpuscles and the amount of hæmoglobin rapidly increase.

The weight of evidence, upon the whole, is very much in favor of the view that the blood of the pregnant woman is normally in a state of serous plethora.[4] Individual variations, however, are numerous and extreme. Favorable environment and sufficient food may induce a state of true polyæmia, while bad hygienic surroundings and inadequate nutriment more frequently reduce the blood to a condition of chlorosis or hydræmia. The explanation of the diminution in the albumen and hæmoglobin is found in the surrender of nutritive material to the fœtus, while the increase in the white corpuscles and fibrin may be ascribed to the extraordinary tissue-changes in the uterus, and the consequent growth of the lumbar and pelvic lymphatic glands. Virchow describes the increase in the number of the white corpuscles as a physiological leucocytosis.

Larcher[5] in 1828 directed attention to temporary hypertrophy of the heart as a constant physiological phenomenon of pregnancy. He asserted that the hypertrophy was restricted to the walls of the left ventricle, which increased from one-fourth to one-third in thickness during the latter months of gestation. The cardiac enlargement, believed to be the cause of the præcordial murmur so often heard during pregnancy, was the consequence of the peripheral resistance opposed by the gravid uterus. Blot concludes from the examination of the hearts of twenty puerperal women that the left ventricle gains about one-fifth in weight. Ducrest confirms Larcher's observation from the measurement of the thickness of the cardiac walls in one hundred women dying in pregnancy or soon after labor. Joulin, De Cristoforis, Spiegelberg, Duroziez,[1] and Robert Barnes have added corroboratory testimony.

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[1] *Centralb. f. Gyn.*, 1879, p. 635.

[2] *Arch. f. Gyn.*, Bd. xxviii. Heft 3, p. 454.

[3] "Untersuchungen über die Veränderungen des Blutes in der Schwangerschaft," *Arch. f. Gyn.*, Bd. xxxi. Heft 1, p. 159.

[4] Kiwisch: *Die Geburtskunde*, p. 285.

[5] *Gazette des Hôp.*, 1857, No. 44.

Then, too, we are in possession of numerous facts which go far to prove the physiological necessity of eccentric hypertrophy of the left ventricle. The augmentation of the total blood-mass, the intercalation of the placental circulation between the uterine arteries and the veins, the increased intra-abdominal pressure rather than the pressure of the gravid womb,—all imply increased cardiac labor, and demand for their explanation either increased force or frequency of the heart's action. Now, it is known that the heart's action during pregnancy increases[2] in frequency only slightly, if at all,[3] while Marey, Mahomed, Macdonald, and others have demonstrated that there is a considerable increase in arterial tension.

All observers agree as to the fact of increase in the area of cardiac dulness.

On the other hand, Gerhardt[4] asserts that no cardiac hypertrophy occurs during gestation, and the increased area of cardiac dulness is explained by the change in the position of this viscus from the distension of the abdominal cavity. Löhlein,[5] citing Friedreich, Virchow, and Dusch, supports Gerhardt's position. Curbelo's[6] conclusions are opposed to the results of the French observers.

Finally, Létulle[7] claims that cardiac hypertrophy during pregnancy is inconstant, but that dilatation of the cavities always takes place.

Upon the whole, the weight of probable evidence is very decidedly in favor of the view that during pregnancy a slight temporary hypertrophy of the left ventricle is a constant and a physiological phenomenon.

De Cristoforis,[8] in the explanation of the cardiac hypertrophy, œdema, and varices of the lower extremities incident to pregnancy, describes a mechanical inferior venous hyperæmia from the pressure of the pregnant uterus on the iliac veins, and a superior arterial hyperæmia from pressure on the aorta at its bifurcation. While no doubt exists as to the fact of hydraulic derangements in the circulation resulting in some degree of arterial hyperæmia in the parts above the diaphragm and in venous hyperæmia of the parts below the plane of the vaginal junction, the interpretation of the phenomena made by De Cristoforis is totally inadequate, for a number of reasons.

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[1] *Gazette des Hôp.*, 1868.

[2] *Archives générales de Médecine.* According to Hémey, the heart of the normal pregnant woman beats seventy-five times per minute.

[3] Pierre Louge: *Le Pouls puerpéral physiologique*, Paris, 1886, p. 38. According to Louge, from seventy-two to seventy-five times.

[4] *De situ et magnit. cordis gravid.*, Jena, 1682.

[5] *Zeitsch. f. Geburt. u. Frauenkrank.*, 1876, p. 482.

[6] *Dis. Inaug.*, Berlin, 1879.

[7] *Archives générales de Médecine*, 1881.

[8] *Annali Universali di Medicina*, 1867.

Increased vascular tension, as pointed out by Robert Barnes, begins early in pregnancy, before the uterus has attained a size sufficient to exert any considerable pressure upon the aorta or iliac veins.

Moreover, Lahs[1] has shown that the gravid uterus has the mechanical value of a sac with relaxed walls filled with fluid, and possesses the same pressure-effect as fluid free in the abdominal cavity, whose surface corresponds in altitude with the liquor amnii. The pressure upon the vena cava and the aorta is accordingly represented by the product of the area of surface of these vessels in contact with the uterine wall, by the altitude of the supernatant column of liquor amnii, the body of the fœtus being of inconsiderable moment.

The difference between the pressure of the gravid uterus—or of fluid free in the abdominal cavity under the condition specified—and the usual intra-abdominal pressure in the non-gravid state is slight. The normal abdominal contents in the non-pregnant state—the intestines, the omentum with its greater or less masses of fat, the mesentery—in the absence of any accumulation of gas in the intestinal canal possess nearly the same specific gravity as the uterus and its contents. Besides the nearly identical specific gravity, the contents of the abdomen, on account of their capability of configuration, possess almost the same mechanical value as fluid. In other words, the weight superimposed upon the pelvic inlet and the vessels there situated at term is nearly the same as in the non-pregnant state, and the mode of expression of this weight in view of its fluid character is the same in the former as in the latter case. Now, since it is perfectly well known that in the non-pregnant state the blood-currents in the vessels mentioned are not disturbed, why should they be interfered with during pregnancy?

The cause of mechanical interference with the blood-currents does not lie in the weight of the uterus and its contents at all. Apart from the compression exerted by the presenting part engaged within the pelvic inlet, the cause lies in the increased pressure upon the blood-vessels by uterine contractions, and the general increase of intra-abdominal pressure which keeps equal pace with the augmentation in uterine volume. This intra-abdominal pressure is obviously greater when the woman is erect and working than when she is recumbent and idle. On this account we find the most extensive varices, other things being equal, in women subjected to severe bodily exertion during gestation, although it must be admitted that individual differences in the tonus of the blood-vessel walls constitute an important factor in these changes. The inferior vena cava is subjected to this increase in intra-abdominal pressure for nearly its entire length, and the return of venous blood from the lower extremities is hindered to a proportionate degree. The aorta, of course, does not remain unaffected by this pressure.

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[1] *Die Theorie der Geburt.*, Bonn, 1877, pp. 5-7.

In the light of Lahs' demonstrations it is perfectly clear that the disappearance of the so-called mechanical œdema of the lower extremities upon the assumption of the horizontal position—a familiar clinical fact—is not due to the removal of the pressure of the gravid uterus from the pelvic inlet, but is caused by the reduction of intra-abdominal pressure by rest in the dorsal decubitus.

The possible applications of this doctrine of increased intra-abdominal pressure as the cause of many of the so-called mechanical disorders of pregnancy are numerous and important.

The hypertrophy of the thyroid gland, and consequent fulness of the neck, apart from any local disease or endemic influence during pregnancy, is such a sensible and frequent phenomenon that the ancients recognized its occurrence. Thus, we see the Venus of Milo, a girl on the verge of womanhood, with a slender, delicate throat, due to the rudimentary state of the thyroid, in strong contrast with the Venus Callipyge, a woman in magnificent maturity, undoubtedly parous, with a broad, full throat and marked thyroid development. The Latins, scarcely less critical than the Greeks, observed the same appearance. Thus Catullus remarks in the "Epithalamium:"[1]

> "Non illam nutrix oriente revisens
> Hesterno poterit collum circumdare filo."

The organ diminishes in size during the puerperium, but remains more voluminous than prior to pregnancy. The enlargement of the thyroid is generally supposed to sustain some relation to the changes in the heart and blood-glandular system incident to pregnancy, the exact nature of which is a matter of speculation.

According to the observations of Birch-Hirschfeld,[2] the spleen increases normally in size and weight. The average weight of the organ at term in the cases examined was 180 grm., as opposed to the normal average weight of 140 grm. in the non-gravid state. This change corresponds with the alterations in the other organs of the blood-glandular system, and is supposed to sustain some important relation to the qualitative changes in the fluids of the circulation.

Rokitansky in 1838, Ducrest and Moreau in 1844, called attention to lamellæ of osseous material, chiefly on the inner surface of the calvarium, external to the dura mater, under the term "puerperal osteophytes." They are situated on the inner surfaces of the frontal and parietal bones, along the furrows of the middle meningeal artery and the sulcus falciformis. Follin and Claude Bernard have observed similar osteophytes on the inner surfaces of the pelvic bones of puerperal women. Occasionally they have been noted on the external surface of the occipital bone. They have been found in rather more than one-half of all the cases examined of women dying after the fifth month; with relative frequency in primiparæ. They are of irregular shape, relatively long, 2–4 mm. in thickness, of reddish-white color in the recent state, and consist chiefly of calcium carbonate, organic matter, and traces of the phosphates. At first it was supposed that these osseous neoplasms were peculiar to pregnancy, but Virchow, Wallmann, and others have observed similar concretions in tuberculosis, chronic hydrocephalus, and syphilis. The ultimate fate of the puerperal osteophytes is unknown. It has been suggested that they represent the excess of ossific material out of which the fœtal skeleton is built up. Robert Barnes thinks they sustain some relation to the preparation of milk and the calcareous changes in the placenta.

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[1] Quoted by Robert Barnes.

[2] *Berl. klin. Woch.*, 1878, p. 324.

## TEMPERATURE.

The bodily temperature during pregnancy does not differ materially from that in the non-gravid state. According to the observations of Gruber and Frankenhäuser, it is slightly lower during the *evening* than during the *day*. This fact is ascribed to the cooling of the blood in its slow course through the dilated veins of the lower extremities and pelvis during the day, when the woman preserves an erect attitude. When she lies down the mechanical obstacle to the return of the venous blood is largely removed, and this dissipation of heat does not occur.

## THE NERVOUS SYSTEM.

The psychical changes incident to pregnancy are subject to innumerable individual variations. As a rule, emotional susceptibility is greatly increased. The pregnant woman becomes exquisitely irritable in the physiological sense of that term, and readily responds to external stimuli that in the non-gravid state would awaken no response. In a small proportion of cases the woman feels unusually well and takes a more active interest in intellectual pursuits and the ordinary affairs of life. More frequently, however, a degree of despondency, entirely beyond the control of the will, is observed. The cheery, amiable woman is apt to become moody and peevish; sometimes a disagreeable disposition is transformed into a happier state of mind. These changes in mental habitude are measurably dependent upon the degree of the desire for offspring. In certain cases the woman becomes dull, apathetic, and inclined to drowsiness.

Functional disorders of sight, hearing, smell, and taste—amblyopia, hemeralopia, slight deafness, perversions of taste and smell; of the sensory, motor, and vaso-motor nerves—neuralgias, hyperæsthesia, vertigo, syncope, local anæsthesiæ, and pareses—are of infrequent occurrence in the absence of structural changes in the corresponding organs. In the absence of a sufficient cause they may be assumed to be due to the qualitative changes in the blood and to the alterations in the genital organs, giving origin to various reflex effects.

The reflex activity of the spinal cord undergoes augmentation, of which a notable example is morning sickness. As at present informed, it is impossible to say whether or not the amount of nervous tissue—in portions of the body other than the uterus—is increased. Analogy favors the view that incremental changes do occur, but we are not in possession of data sufficient to settle this question.

## RESPIRATION.

The tests with the spirometer by Küchenmeister, Fabius, and Wintrich indicate that the vital capacity of the lungs is not diminished during pregnancy. Gerhardt's observations show that the width of the thoracic base is increased, and that the position of the diaphragm is not materially altered, although its downward excursions are restricted and respiration becomes thoracic instead of abdominal. In Waldeyer's plane frozen section the highest point of the diaphragm is on a level with the middle of the eighth thoracic vertebra, while in Braune's[1] section of a woman in the beginning of pregnancy the cordiform tendon corresponds to the lower border of the eighth thoracic vertebra. Dohrn[2] found, by means of the cyrtometer, the antero-posterior diameter of the thorax diminished, while the breadth of the base was increased. Marked diminution in the vital capacity of the lungs was noted in 60 per centum of the women examined—near term—as compared with the results obtained from examination of the same women twelve to fourteen days after delivery.

The frequency of respirations early in pregnancy, and the dyspnœa near term, especially when the woman is the subject of a contracted pelvis or spinal curvature, have led Tarnier, Chantreuil, and others to conclude that both the vital capacity and the thoracic space are diminished. The relief in breathing experienced so commonly after the sinking of the womb and engagement of the presenting part just before labor is an important fact in favor of the view of the French observers.

Andral and Gavarret assert that the exhalation of carbonic acid is augmented during pregnancy, as it is after the cessation of menstruation from other causes.

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[1] Tab. ii. A.

[2] *Mon. f. Geburts.*, Bd. xxviii., 1866, p. 457.

### THE ALIMENTARY TRACT.

Nausea, and even retching or vomiting, with the bringing up of some glairy fluid, on first rising from the recumbent posture are phenomena of early pregnancy so nearly constant and so devoid of injurious effects that they are justly regarded as physiological. On account of the time of occurrence the symptom is generally known as the "morning sickness," although it is exceptionally observed only in the afternoon. The "morning sickness," beginning commonly at the second month, sometimes immediately after conception, ceases spontaneously, as a rule, between the third and fourth months. Nausea near term may be physiological from pressure of the fundus, but in the absence of any local cause should be regarded with suspicion as a possible prodrome of urinæmia. The symptom is observed with greatest relative frequency in primiparæ. The causation of morning sickness is obscure, but probably consists in some anomaly of innervation. Robert Barnes regards the symptom as the expression of high nervous tension, and the stomach as "the seat of election for the discharge of superfluous nervous energy." Bedford,[1] indeed, insists upon the old observation that in the absence of morning sickness other, more distressing, disorders are present, such as tendency to syncope, aptitude to miscarriage, and the like. The increase in the size of the womb and the qualitative alterations in the blood cannot be invoked as etiological factors, since these changes are of moment only during the latter half of pregnancy, after the disappearance of the symptom. The essential factor in the process of digestion—assimilation—is not changed so long as the nausea remains within physiological limits.

The appetite of the pregnant woman increases even during the period of nausea, and is proverbially whimsical. Its caprices, popularly known as "longings," are dependent in certain cases upon the morning sickness; in other cases, especially in primiparæ, they are assumed or imaginary, in accordance with the traditional belief that they are incident to the condition of pregnancy. Veritable examples of pica—perversion of appetite—although infrequent, are recorded. Thus, depraved longings have been shown for green apples, chalk, pepper-grains (Cazeaux), bits of charred wood (Dubois), and even for human flesh, as "in the case of the woman who, craving her husband's flesh, killed him, and to prolong her enjoyment salted him down."[2]

The secretion of the salivary glands is increased in exceptional cases and becomes more aqueous.

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[1] *Diseases of Women and Children*, p. 551.

[2] Robert Barnes: *System of Obstetric Medicine and Surgery*, Philada., 1885, p. 176.

## THE LIVER.

Tarnier in 1857 concluded, from a series of observations upon women dying during or shortly after labor, that the liver is usually enlarged as the result of a peculiar fatty infiltration. This change he describes in the following words:

"The color of the hepatic tissue is not uniform, its substance being sprinkled with minute yellow spots so numerous as to give it the appearance of granite. The spots also seem to form so many projecting points, of a size varying from that of a pin's head to that of a millet-seed. Sometimes they are disseminated, at others aggregated, forming in the latter case little insular patches, though sometimes the agglomeration is such as to give rise to a yellow spot of an inch or more in diameter. This appearance is not limited to the surface of the liver, but will be found in any section made through the substance of the organ. A microscopic examination of this tissue, made in connection with Dr. Vulpian, revealed the hepatic cells in normal condition, mingled with an abundance of fat-globules."

De Sinéty has noted the same phenomenon in the lower animals, and thinks that the change is physiological—an opinion shared by Robert Barnes and Ewart, who have also observed this infiltration.

According to De Sinéty, the infiltration commences around the intralobular vein and proceeds toward the periphery, the reverse of the order in which pathological fatty infiltration or metamorphosis affects the lobule.

The functional significance of these structural alterations in the liver will be discussed under another topic.

## NUTRITION.

Pregnancy exercises normally a favorable influence upon nutrition, and the body-weight, apart from fœtal development, increases progressively, even in cases of slight morning sickness, from the beginning to the end of gestation. Gassner[1] has shown that the body-weight increases 2.4 kg. during the eighth lunar month, 1.69 kg. during the ninth, and 1.54 kg. during the tenth. This augmentation in metabolic activity seems to be dependent upon the nutritive energy imparted by the growing ovum, since the same investigator has observed a sudden remarkable diminution in weight (2–3 kg.) in three cases following the death and retention of the fœtus in utero for a period varying from eight to fourteen days.

In general, it may be said that a woman's weight is about one-thirteenth greater at the end of pregnancy than it was at the commencement.

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[1] "Ueber die Veränderungen des Körpergewichtes bei Schwangeren, Gebärenden und Wöchnerinnen," *M. f. G.*, Bd. xix., 1862.

Of all the tissues in the body, apart from the genitalia, the adipose tissue increases most in bulk during gestation, especially during the second half. The deposits of fat are observed particularly in the mammary glands, the paniculus adiposus of the abdominal parietes, the pudenda, the superficial fascia of the hips and gluteal region, the omentum, and the fatty peripheral layer of the pelvic connective tissue. These changes impart the familiar rotundity to the figure. The store of adipose tissue thus laid away constitutes so much potential energy to be converted by the metabolism of the body in part into milk, in part into the actual energy of heat and mechanical labor.

## THE URINE.

It is asserted that the kidneys become larger during pregnancy as the result of heightened functional activity.

The urine undergoes quantitative and qualitative changes. The total amount excreted during twenty-four hours is augmented in its aqueous elements in consequence of the alterations in the blood-mass and the high arterial tension. According to Winckel,[1] the daily excretion of urea, sodium chloride, the sulphates, and phosphates is not changed. Chalvet and Barlemont (1870), however, have found an increase in the chlorides and a diminution in the phosphates, sulphates, urea, uric acid, creatin, and creatinin. Lehmann and Donné suggest that the deficiency in these substances is due to their use in the development of the fœtus.

Nauche in 1831 described the formation of an iridescent filmy covering appearing upon the urine of the pregnant woman several hours after its excretion, and being precipitated to the bottom of the vessel on the fifth day. He termed this covering the kyesteinic pellicle, attaching to it diagnostic significance. Elisha Kent Kane, the Arctic explorer, Braxton Hicks, Cazeaux, Scanzoni, and numerous others have observed the same phenomenon in the urine of virgins and of men, and have demonstrated that the so-called kyesteinic pellicle consists chiefly of the ammonio-magnesian phosphates and vibriones, sustaining no necessary relation to pregnancy.

Blot[2] in 1856 found glucose in the urine of one-half of the pregnant women examined, in quantities varying from 0.1–1.2 per centum, and asserted that the quantity stood in direct relation to the activity of the mammary glands. Kirsten[3] confirmed Blot's observation, but referred the glycosuria during lactation to a pathological increase in the glycogenic function of the liver. Brücke[1] in 1858 affirmed that traces of glucose were almost constantly found in normal urine, and that the quantity in the urine of puerperæ was frequently very much increased within physiological limits.

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[1] *Stoffwechsel bei der Geb. und im Wochenbett*, Rostock, 1865.

[2] *Gaz. des Hôp.*, 1856, No. 121.

[3] *M. f. G.*, 1857—59.

Tarnier, rejecting the notion of a physiological resorption diabetes, ascribes the glycosuria of pregnancy to the hepatic changes already indicated.

Traces of albumen are found in the urine of a small proportion of pregnant women in the absence of demonstrable structural changes in the kidney. In many cases this so-called physiological albuminuria is referable to a catarrhal inflammation of the vesical mucous membrane. Then, too, as pointed out by Leube and Mahomed, albuminuria without tube-casts may occur as the result of passive congestion of the kidneys or increased vascular tension. In view of the grave significance of Bright's disease during pregnancy, the symptom always demands serious attention and calls for frequent examinations of the urine through a considerable period of time. The general condition of the woman must also be attentively observed to determine whether or no there are other symptoms of the existence of grave kidney disease. Pavy has described a condition under the term *cyclic albuminuria*, in which albumen is found at a certain time of the day and not at any other. The albumen appears after rising, attains a maximum within one and a half or two hours, and then declines, completely disappearing when the woman resumes the recumbent posture. This condition is probably dependent upon some change in the blood-vessel walls, and seems to be of no serious import. The condition is also observed in the non-pregnant woman and in the male.

## THE SKIN.

The functional activity of the sebaceous and sweat glands and the hair-follicles is greatly increased during pregnancy. The changes in the mammary glands, belonging to the class of skin-glands, have already been indicated. Robert Barnes is responsible for the observation that "women who had been losing hair when not pregnant found its growth restored during pregnancy, and falling out again after labor."

Among the physiological anomalies, the various deposits of pigment and the formation of striæ or lineæ albicantes are especially worthy of mention. Deposits of pigment are observed around the nipple—the primary and secondary areolæ—along the median line of the abdomen from the pubes to the navel, around the navel—the umbilical areola of Montgomery—sometimes along the median line from the umbilicus to the ensiform process, in the labia majora and nymphæ, and in the face. Irregular pigmentations are occasionally seen involving the entire skin surface of the breasts, as in the Samoyed women, or of the abdomen, as in the case described by Bomare,[1] or of a lower extremity, as in the case referred to by Le Cat.

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[1] *Sitzungsberichte der Kais. Acad. d. Wissensch.*, Wien, xxviii., xxix., 1858.

Patches of pigmentation are often observed on the forehead, root of the nose, and the upper lip, giving origin to the expression, the "mask of gestation." Joulin has seen this appearance particularly in women exposed to the sun and atmospheric influences, as among the peasantry of France. McLane[2] reports a case in which the disfigurement was so great as to compel the woman to remain within her house. These pigmentations vary greatly as regards extent and intensity. They are usually more marked in brunettes than in blondes. They gradually fade away after labor, but seldom completely disappear.

Their causation is obscure. Jeannin[3] suggests the amenorrhœa of pregnancy. Robert Barnes thinks they are trophic in origin, and refers them to a hypothetical transitory hypertrophy of the suprarenal capsule. Laycock regards them as produced (1) from imperfect oxidation of carbon, (2) from imperfect elimination of carbon, and (3) from excess in the production of carbon from highly carbonaceous foods.

A parasitic skin disease, closely allied to pityriasis versicolor, occurs so frequently during pregnancy that it has received from Elsässer the name of *pityriasis gravidarum*. Spiegelberg has observed this disorder most frequently in enfeebled individuals—an observation confirmed by James Nevins Hyde. The efflorescence of this disease resembles certain of the anomalous pigmentary deposits incident to pregnancy. The differential diagnosis, however, is usually easy. Microscopical examination of the superficial scales reveals the characteristic fungi in pityriasis, and the disease disappears under appropriate treatment—*i. e.* the local application of ten grains of veratrin in one ounce of alcohol or thorough washing with the tincture of green soap.

The skin of the abdominal walls, stretched by the growing uterine tumor, undergoes hypertrophy and the adipose tissue of the superficial fascia is agumented. The umbilical depression is diminished at the end of the fifth month, and is on the same plane with the surrounding integument at the end of the sixth month. During the last four months it is everted to a variable extent. In the very large majority of cases the growth of the abdominal integument does not keep pace with the growth of the uterine tumor; its elasticity is overcome, and pinkish or bluish-red streaks appear. After labor these streaks become white or pearl-colored. Technically, they are known as lineæ albicantes, stri gravidarum, or the so-called cicatrices of pregnancy. The striæ gr darum,[1] usually appearing during the last three months of pregnancy, are caused by a thinning of all the skin-layers, due to pressure-atrophy, partial obliteration of the lymph-spaces, and to a rearrangement of the connective-tissue elements, which now run parallel to one another. They are found in greatest numbers at the site of the greatest tension of the cutis, in the lower half of the abdomen and to the sides, where the femoral fasciæ are intimately united with the skin.[2] They pursue a course at right angles to the direction of greatest tension, which is transverse. Accordingly, they run parallel to the linea alba. Around the navel they form concentric rings, since the direction of tension at this point is radial and concentric.

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[1] Laycock: *The Nervous Diseases of Women.*

[2] *New York Medical Journal*, May, 1878.

[3] *Gaz. hêbdom.*, 186

The lineæ albicantes are also found in the gluteal regions, anterior, posterior, and inner surfaces of the upper femoral region, and in the cutis covering the mammary glands. Crede has found them absent in 10 per centum of all the cases examined; Hecker, in 6 per centum.

They are not peculiar to pregnancy, but occur in cases of rapid distension of the abdomen from other causes, as ascites, ovarian tumors, and the like. Schultze has observed them in 36 per centum of women who had not borne children.

## THE OSSEOUS SYSTEM.

On account of the growth and inclination forward of the pregnant uterus, the centre of gravity tends to fall in front of the pubes, and in order to maintain her equilibrium in the erect posture the woman is obliged to throw her head and shoulders backward. The incurvation of the spine is accordingly increased, while the pelvic inclination is diminished. This change in carriage is especially marked in women of low stature, causing a peculiar strut in their gait not destitute of diagnostic significance.

Delay in the ossification of the callus following a fracture is occasionally observed during pregnancy. Padieu[3] describes an unusually clear case in which the tibia and fibula of one leg were broken nine days after the suppression of menstruation. Union was delayed during the entire period of pregnancy, but began to take place ten days after delivery, and was perfect at the end of one month. Upon the hypothesis that the relation between the delay in union and pregnancy was necessary, and not mere coincidence in point of time, it is not improbable that the lime salts were used up by the fœtus at the expense of the callus.

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[1] S. C. Busey: *Trans. Am. Gynæc. Soc.*, vol. iv.

[2] Krause und Felsenreich: "Die Spannungsverhältnisse der Bauchhaut bei Gravidität," *Arch. f. Gyn.*, xv., 1880.

[3] *Journal de Médecine et de Chirurgie pratique*, 1887.

## THE DIAGNOSIS OF PREGNANCY.

The signs of pregnancy have been variously classified as the *rational* and *sensible* signs, or as the *presumptive*, the *probable*, and the *certain* signs, or as the *subjective* and *objective* signs. Most systematic writers, however, are in the habit of discussing each symptom in the order in which it appears in point of time. This plan recommends itself for simplicity and for ease of application in practice. The entire duration of pregnancy is divisible into three equal periods, or trīmesters, by certain well-defined groups of symptoms. This division is of great convenience in the discussion of the subject, and, at the same time, of practical value in the diagnosis of the time of gestation and the probable duration of the condition.

The importance of as nearly a purely objective diagnosis as the conditions of the concrete case will permit needs no special emphasis at the present day. Fortunately, the objective changes incident to pregnancy are so numerous, occur so early, and many of them are so characteristic that commonly the physician is able to form a positive opinion upon adequate evidence derived exclusively from his own perceptions.

### I. FIRST TRIMESTER.

1. SUBJECTIVE SIGNS.—*Suppression of Menstruation.*—The first sign of pregnancy is usually the suppression of the menses. Cazeaux, indeed, was accustomed to attach some importance to the more voluptuous sensation and the more general erethism alleged to be characteristic of fruitful coition. As the human female is essentially passive in the act of conception, these phenomena are destitute of diagnostic significance. Suppression of the menses in perfectly healthy women who have been previously regular is a strongly presumptive sign of pregnancy, and the degree of probability increases with the duration of the period of amenorrhœa. The sign is of great practical value, inasmuch as it affords probably the most reliable datum upon which to predict the day of confinement.

It is subject to three familiar fallacies:

1. Menstruation may be arrested by causes other than pregnancy. Change of climate, exposure to cold, mental impressions, certain morbid states, are frequently operative in the suppression of the menses independently of pregnancy. It is a matter of common observation for perfectly healthy English women emigrating to America to miss one or two periods as the result of the change in climatic relations. Intense desire for offspring, as in newly-married women, or extreme fear, as in unmarried females who have subjected themselves to the risk of impregnation, is not infrequently productive of a brief period of amenorrhœa. Tuberculosis deserves mention in the first line, among

the morbid conditions which arrest menstruation. Then, syphilis and anæmia from all causes are only slightly less important etiological factors in amenorrhœa than consumption.

2. Pregnancy may occur in the absence of menstruation. Conception may take place during the amenorrhœa of lactation. It has been shown that menstruation is re-established in the large majority of women who suckle their babes within six months after labor; according to Carl Braun,[1] in 71 per centum. During this period pregnancy frequently occurs. Hodge cites a case, coming under his own observation, of a woman who usually menstruated twice annually. She "became pregnant seven months after the last appearance of the menses and six years after marriage."[2] A girl may become pregnant before puberty; "she may bear fruit before flowers" (De la Motte). Then there are a few authentic cases on record of pregnancy after the climacteric.

3. A more or less periodic discharge of blood from the genital tract, resembling menstruation, may take place during the early months, or even during the entire period, of pregnancy. Menstruation is in all probability suspended during gestation. But hemorrhages from pathological conditions of the vaginal portion, cervical mucosa, decidua, chorion, from polypi and placenta prævia, are sometimes observed. Women are accustomed to interpret any discharge of blood from the genital canal as menstruation, and the imagination supplies the fact of periodicity when it does not actually exist. In a certain proportion of the cases of so-called pseudo-menstruation during the first three months of gestation, before the union of the decidua vera and decidua reflexa, the pathological condition consists in a chronic decidual endometritis, sometimes of a catarrhal, sometimes of a hemorrhagic, character.

In forming an estimate of the relative diagnostic value of this sign, it is possible, therefore, to conclude that suppression of the menses in a perfectly healthy woman, previously regular, is presumptive of pregnancy in the absence of any other adequate cause. In this, in common with the other subjective signs, reliance must be placed upon the statements of the patient—obviously a very precarious basis even when there is no motive for deception.

*Morning Sickness.*—Nausea or sickness in the morning upon rising from the recumbent posture, sometimes accompanied by retching or vomiting, with the bringing up of some glairy fluid, is usually noticed about the beginning of the second month. Infrequently, the symptom is observed during the afternoon and very soon after conception. Morning sickness is most marked in primiparæ, in women of highly nervous temperament, occurs in considerably more than one-half the number of cases, and ceases commonly between the third and fourth months, very seldom persisting throughout gestation. In a small proportion of cases ptyalism occurs in connection with morning sickness. Dewees attached some diagnostic significance to spitting a white frothy mucus—"cotton spitting," as he termed it. Toothache during pregnancy may be a purely functional disorder. In the majority of cases, however, actual caries is present. During gestation the secretions of the buccal cavity are frequently altered and become sufficiently acid to dissolve the lime salts out of the enamel. Again, when for any reason an insufficient quantity of lime salts is ingested with the food, the fœtus is supplied with ossific material derived in part from the maternal teeth. Popular recognition of these dental changes has given origin to the familiar saw, "For every child a tooth." A case of early pregnancy has recently come under the writer's observation in which the condition was inferred by the patient's dentist from the changes in her teeth.

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[1] *Lehrb. d. g. Gyn.*, Wien, 1881, p. 211.

[2] *A System of Obstetrics*, p. 71.

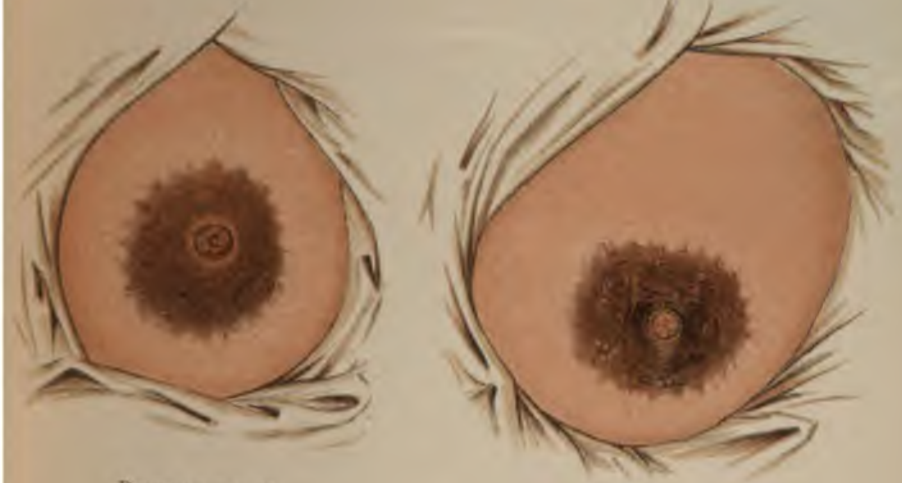
Morning sickness, associated with amenorrhœa, in the absence of any sufficient morbid cause, is a presumptive sign of pregnancy, of value chiefly on account of its early occurrence.

2. OBJECTIVE SIGNS.—*Changes in the Mammæ.*—About the end of the second month, according to Montgomery, the nipple swells, becomes turgid, more erectile, and projects forward. It increases in sensibility and deepens in color. The apex is sometimes covered with minute branny scales, formed by the drying of the colostrum, a few drops of which can be made to exude, by dextrously compressing the gland from the base toward the nipple, as early as the third month. (SEE PLATE.)

The areola enlarges and swells, becoming puffy and presenting the appearance of emphysematous tissue. Its color deepens, being darker in women with black hair and eyes and in brunettes than in blondes. In the negress the areola becomes jet black. The sebaceous glands of the areola, ten to twenty in number, increase in size and appear as papular elevations above the level of the skin. They are described by Montgomery as miniature mammary glands intimately connected with the lactiferous ducts, and their secretions keep the areola moist.

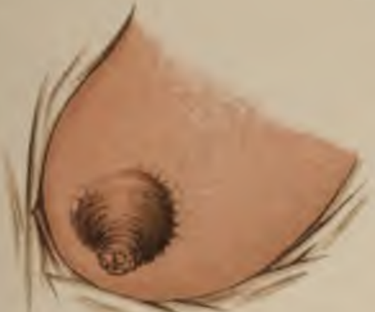
Toward the fifth month a secondary areola is frequently formed in brunettes around the outer margin of the primary areola. It consists of a number of round white spots arranged in a circle, presenting an appearance commonly described as resembling that of dust-covered white blotting-paper from which the dust has been discharged by a shower of water-drops. These spots are free from pigment, and each one has in its centre a small black spot, indicating the orifice of a sebaceous gland and the position of a very minute hair.

At the same time with these changes the mammary glands increase in size, become firmer in consistence, and painful spontaneously or on pressure. Blue veins are seen under the skin pursuing their tortuous courses from the nipple toward the periphery. At a later period, when

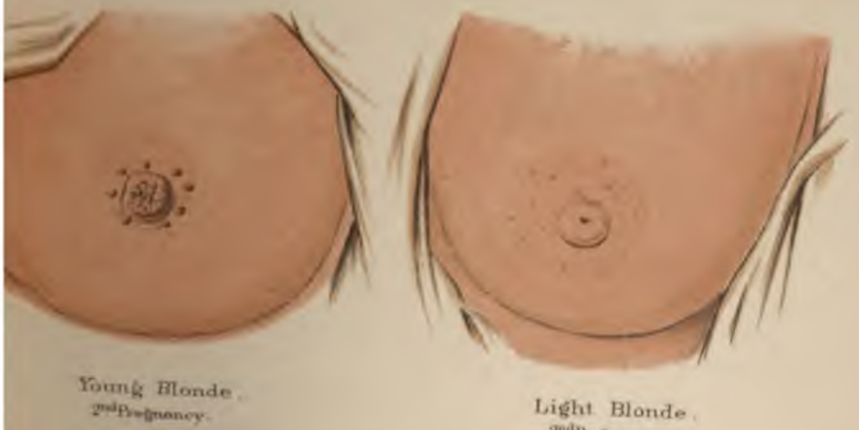


Brunette æt. 19.
1st Pregnancy.

Dark Brunette æt. 18.
1st Pregnancy.



Dark Blonde æt. 25.
1st Pregnancy.



Young Blonde.
2nd Pregnancy.

Light Blonde.
2nd Pregnancy.

Appearance of the Areola in Pregnancy.
Spiegelberg.

T. SINCLAIR & SON, LITH. PHILA.

d attains greater proportions, lineæ albicantes often make their nce.

not uncommon to see the breasts diminish in size about the r fifth month, and remain in this state until term. In certain pecially in elderly primiparæ, the changes in the volume of the are insignificant, and then the function of lactation is seldom established.

is nothing remarkable in the causation of these mammary inasmuch as the breasts constitute a part of the genital system. nastomotic communication exists between the arteries supply- mammary glands and those distributed to the uterus and ova- he perforating branches of the internal mammary artery supply the mammary gland. The superior epigastric artery, one of inal branches of the internal mammary, anastomoses with the epigastric, which arises from the external iliac a few lines above 's ligament. The inferior epigastric sends off a spermatic which passes along the round ligament and anastomoses with ian artery derived from the aorta and the uterine artery derived anterior trunk of the internal iliac. The nervous communi- effected through the sympathetic and spinal nerves.

hief fallacy to which this sign is liable depends upon this inti- lationship between the mammæ and the genitalia. Certain conditions of the uterus and ovaries sometimes induce such l nutritive disturbances that mammary changes, similar in kind ering only in degree from those incident to pregnancy, ensue. many cases of chronic metritis, of rapidly-growing uterine a, of ovarian cystomata, the mammary phenomena are prom- mptoms. Now, while at the fourth or fifth month, or later, mmary changes incident to pregnancy are usually so well that there is seldom any difficulty in recognizing their origin, y in primiparæ, yet in early pregnancy—during the first twelve the appearances due to pathological conditions of the uterus ries are frequently so nearly identical in kind and degree that rentiation is impossible and the sign altogether invalidated.

ing sensations and slight swelling of the mammary glands, with ng of a drop of sero-lactescent fluid in exceptional cases, are equent phenomena of menstruation in women of highly nervous ment.

ultiparæ the darkening of the areolæ, the prominence of the lary tubercles, and the erectility of the nipple remain in some ermanent, and colostrum is very frequently present many years cessation of lactation. The sign accordingly is almost desti- diagnostic significance during the early months of gestation in who have borne children.

The mere presence of colostrum in the breasts of women who have not borne children is never a sign of decisive value. Baudelocque presented to the Academy of Surgery of Paris in 1783 a female child eight years old who had suckled a little brother for more than a month. It is alleged that milk has been found in the breasts of adult males. Tanner says that "it is not uncommon in Western Africa for young girls who have never been pregnant to regularly employ themselves in nursing the children of others, the mammæ being excited to action by the application of the juice of one of the Euphorbiaceæ." Sexual intercourse and mechanical irritation of the mammæ act as stimuli to the lacteal secretion, as in the case of nulliparous puellæ publicæ. In this class of women the appearance of colostrum in the absence of pregnancy is a matter of common observation.

The diagnostic value of the changes in the mammæ as a sign of early pregnancy is accordingly limited to cases of primiparæ. In these women the sign acquires decisive value just in proportion as it is possible to eliminate the fallacies mentioned. In the large majority of cases it is only a presumptive sign. During the second half of pregnancy its diagnostic significance is greater in both primiparæ and multiparæ, and when well marked may be included among the certain signs. The anecdote is related of John Hunter that on inspecting the mammæ of a young girl whose body was arranged for a post-mortem examination, he pronounced her pregnant. The hymen was found to be intact, but upon opening the abdomen the diagnosis was verified.

The advantages of the mammary changes as a sign of pregnancy over other objective alterations consist in their early and almost constant occurrence, and in the possibility of examination of the breasts without exciting the suspicion of the patient. The negative value of the sign is sometimes as great as the positive information it affords. Thus, in the entire absence of changes in the mammæ, especially in women with dark hair and eyes, we are occasionally enabled to deny the fact of pregnancy at all advanced. Then, in the diagnosis of pregnancy during the amenorrhœa of lactation—always a serious and very frequently an embarrassing problem—the negative value of the sign is obviously great. Tyler Smith remarks on this subject: "Suppression of the milk in persons who are nursing and liable to impregnation is a more valuable sign of pregnancy than the converse condition."

Changes in the Genitalia.—*Violet Hue of the Vagina.*—T violet hue of the vaginal mucous membrane, commonly compare the color of wine-lees, has been described as a sign of early pregna particularly by Jacquemin and Kluge.[1] The latter observer appare directed his attention to the "bluish coloration of the vagina at the

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[1] Sommer: *Berl. Med. Central Zeitung*, Jan. 14, 1837.

-sac surrounding the os uteri." English systematic writers since
ve mentioned the sign casually, but, with the exception of Robert
rnes,[1] have not attached to it special diagnostic significance. Chad-
ck[2] has recently called attention in an admirable paper to the value
the bluish coloration of the vaginal entrance, and particularly of
e anterior vaginal wall just below the meatus urinarius, as a sign of
rly pregnancy. As described by this observer, the color begins as a
le violet in the early months, in contrast with the usual pinkish hue
the vaginal mucosa, becoming more bluish as pregnancy advances,
til it often assumes finally a dusky, almost black, tint.

This change in coloration is due not so much to pigmentation and
e stasis of venous blood as to actual hypertrophy of the corpus cav-
nosum vestibuli and the venous plexuses of the vaginal walls.

Although probably always present late in gestation, the time at
hich this sign makes its first appearance varies greatly. According
Kluge, the bluish coloration of the vaginal vault begins as early
the fourth week, or "at the time when menstruation would have
curred had conception not taken place." Out of the 281 cases of
egnancy observed by Chadwick, the changes were *suggestive* of
egnancy in 34 per centum at the end of the second month, but
*agnostic* in only 13 per centum. At the end of the third month
e color was *suggestive* of pregnancy in 27 per centum, and *diagnostic*
46 per centum. Out of 141 cases of pregnancy observed by Far-
w,[3] the blue color was suggestive of pregnancy in 1 case at the end
the sixth week. Out of 22 cases, it was suggestive at the end of
second month in 10, and diagnostic in 1; out of 28 cases, it was
ggestive in 5 at the end of the third month, and characteristic in 11.

The sign is obviously not infallible. It is frequently absent early
pregnancy, and its later presence is of little practical value. Chad-
ck was unable to discover the blue color in 17 per centum of the
ses at the end of the third month; Farlow, in a still greater propor-
n of cases.

Then, causes other than pregnancy may produce nearly identical
pearances. Montgomery has observed a blue coloration of the
gina after menstruation; and it is a familiar fact that cattle-breed-
s determine whether or not an animal is in heat by inspection of the
lvar orifice and the vagina. Under these conditions the mucosa is
equently black as ink (Tarnier). Chadwick reports one case of ero-
sm with the occurrence of a bluish coloration sufficient to give rise to
ubt. Vaginal cicatrices, not at all infrequent in women who have
rne children and have been the subjects of the forceps operation, con-

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[1] "Diagnosis of Early Pregnancy," *Brit. Med. Journ.*, 1868, vol. ii. pp. 631, 632.

[2] *Trans. Am. Gyn. Soc.*, vol. ii., 1886, p. 399.

[3] *The Boston Med. and Surg. Journ.*, vol. cxvii. No. 3, 1887.

stitute a source of error. Finally, the stasis of venous blood, as in certain cases of chronic metritis and of uterine myomata, sometimes causes a cyanotic hue which it is utterly impossible for the unskilled observer to differentiate from that incident to pregnancy.

Notwithstanding its fallibility under the conditions indicated, it must be admitted that the sign is of great practical value, especially to the acute observer.

Its diagnostic value is well expressed in the conclusions deduced by Chadwick:

"1. That its absence is not to be accepted as evidence that pregnancy does not exist, especially in the first three months, when satisfactory evidence is most needed.

"2. That from (and including) the second month this color is generally present, and often of such character as to be diagnostic."

As largely a vital phenomenon, and only in a minor degree dependent upon mechanical obstruction, it would seem probable, on *a-priori* grounds, that the sign is of value in the diagnosis of extra-uterine pregnancy. As a matter of fact, Chadwick has found the blue coloration "suggestive" as early as three and a half months in two cases of ectopic gestation.

The presence of this sign is of evident value in women with very fat or tense abdominal walls and in cases of conception during the amenorrhœa of lactation. In a case of the latter description recently coming under the writer's observation the diagnosis of pregnancy was established by the presence of this blue coloration.

*Softening of the Vaginal Portion.*—Early in pregnancy the vaginal portion begins to grow softer from below upward, the change in consistence being particularly marked in multiparæ. The examining finger is sometimes able to detect a peculiar velvety softness of the superficial portion of the lips of the os as early as the sixth week in women who have borne children; at the same time, the terminal phalanx may be introduced within the more or less patulous os. The alteration in density is present in some degree in almost all normal cases at the end of the third month. During the latter weeks of gestation the vaginal portion frequently does not differ sensibly in consistence from the vaginal walls.

The change in density is due to the congestion of the uterus, the tissue-changes, increased secretion of the cervical glands, and especially to the serous infiltration caused by the intermittent uterine contractions.

The sign is absent during early pregnancy in certain morbid states of the vaginal portion, as in hypertrophic elongation, and it may result from various causes, as hæmatometra, acute metritis, and the like.

Holst and Goodell have attached considerable diagnostic value to this sign. The latter observer has even given the off-hand rule: "When the cervix is as soft as one's lips, the woman is probably pregnant; when it is as hard as the tip of one's nose, the womb is most likely empty"—a rule capable of general application only during the second and third trimesters. The negative value of the sign, as indicated by Goodell, is often of some importance in the diagnosis of pregnancy during the latter months. Given a case of uterine enlargement corresponding to the seventh or eighth month, and of persistence of the vaginal portion in its original length and consistence, the non-existence of advanced pregnancy can usually be safely inferred. During the first three months the softening of the vaginal portion affords evidence only of a probable nature.

*Softening and Compressibility of the Lower Uterine Segment.*—Hegar[1] has recently described an alleged new and reliable sign of early pregnancy, which consists in changes in the lower uterine segment. The lower uterine segment becomes softer and more compressible in contrast with the thick, dense cervix below and the corpus above. These alterations are most marked in the median section of the lower uterine segment, while the borders remain relatively dense, appearing at times like cords. The compressibility of this median section is asserted to be sometimes so great that the mass of tissues grasped between the fingers seems to be no thicker than a visiting-card, or actual solution of continuity between the body of the uterus above and the neck below is apparent. Martin and Horwitz had previously described softening and compressibility of the lower uterine segment in hypertrophic elongation of the cervix uteri during gestation. Both observers admit that these changes may be so great as to create the impression of the existence of two distinct and separate tumors, the lower one corresponding to the hypertrophied neck, the upper one to the corpus uteri. However, they interpreted the phenomena as being pathological, and not physiological.

This sign, it will be noted, is perfectly distinct from the sensation of uterine fluctuation through the anterior uterine wall dependent upon the presence of liquor amnii. Rasch[2] asserts that this fluctuation can always be felt as early as the second month, and attaches to it considerable diagnostic importance.

According to Compes,[3] Hegar's assistant, to elicit the sign under discussion the index finger of either hand is introduced within the rectum, while the thumb of the same hand is placed upon the vaginal portion. The index finger passes above the utero-sacral ligaments, marking the boundary between the cervix and the lower uterine segment, into the pocket of the sphincter ani tertius. If the aperture of the sphincter ani tertius is not readily found, one-fourth of a liter of

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[1] Reinl: *Prager medicin Wochenschr.*, 1884, No. 26.

[2] *Brit. Med. Journ.*, vol. ii., 1873.

[3] *Berl. klin. Wochenschr.*, 1885, No. 38.

lukewarm water injected into the rectum facilitates the search. The other hand, placed on the abdomen, presses the uterus downward against the finger in the rectum, when the lower uterine segment, the cervix, and the corpus uteri can be easily touched. Reinl records six cases of the diagnosis of early pregnancy by this sign alone. Compes describes eight cases in which the sign was sufficient to establish the fact of pregnancy. In one case the diagnosis was made as early as the seventh week.

The cause of these changes lies in the thinness of the lower uterine segment—the thinnest portion of the entire uterine body—the softening and œdema incident to pregnancy, and the great elasticity of the uterine contents and of the walls of the upper uterine segment, which permit the egg to be pressed upward.

Any attempt to fix the limitations and to point out the fallacies to which this sign is liable at present would be premature. The facts in our possession as to its occurrence and diagnostic significance are entirely too meagre to warrant generalizations. In passing it may be said that Compes failed to detect the sign in one case of early pregnancy, and observed phenomena somewhat similar in cases of retroversion of the uterus. Obscure and confused notions as to the objective changes embraced under Hegar's sign have rendered invalid the conclusions of certain American observers.

*Changes in the Uterine Tumor.*—Changes in the size, form, position, consistence, and elasticity of the uterine tumor—facts elicited upon bimanual exploration—yield valuable evidence in the diagnosis of early pregnancy. At the end of the third month the uterus forms a fig-shaped tumor the size of the head of a mature fœtus, of a certain dough-like softness and elasticity, which to the educated touch is well-nigh characteristic. When in normal position the fundus is a few lines above the plane of the inlet and inclined forward, while the cervix is tilted backward, upward, and to the left of the median line, the entire organ being in a state of physiological anteversion or anteflexion. This nutation of the fundus causes a slight elevation upward and backward of the posterior vaginal wall, while the anterior vaginal wall is rendered slightly convex downward, and is put upon the stretch—the "anterior vaginal roof-stretching" of Robert Barnes. In some cases these alterations can be detected as early as the eighth week, but they are more generally available at the period just indicated.

To elicit these signs favorable conditions with respect to the position of the uterus, and more particularly with respect to the flaccid state of the anterior abdominal wall, are necessary. In women with a very fat or tense abdominal wall it is usually difficult, and frequently impossible, to detect these alterations without the aid of anæsthesia.

The morbid states which sometimes produce closely similar changes are chronic metritis, submucous or intramural fibroids, and hæmatometra. Chronic metritis may be usually excluded by the greater density and sensitiveness of the uterine walls, subjective symptoms, and the history of the case. But pregnancy frequently occurs in a uterus in the state of chronic infarct with relatively dense and sensitive walls—an obviously perplexing situation.

In submucous and symmetrically parietal fibroids the relatively hard consistence of the uterine walls and the history of the case aid in the differential diagnosis. In cases of soft myomata or of pregnancy in uteri, the loci of myomata, the diagnosis becomes very difficult. Hæmatometra yield to the examining finger the sensation of a tense cyst, sometimes of fluctuation. Then the anamnesis in these cases is of especial value.

Alternations in density, due to the intermittent contractions of the uterus, aid materially in the differential diagnosis. This sign will be discussed in the succeeding pages. Then the rapid rate of growth of the uterine tumor in pregnancy—a fact brought out by repeated examinations—is not simulated by any of the morbid states mentioned.

The diagnostic value of these symptoms, obviously great, has risen much in the estimation of the profession in recent years since bimanual exploration is so frequently and so generally practised under the influence of gynecology. Subject to the fallacies mentioned, the alterations in the size, form, position, consistence, and elasticity of the uterine tumor may be said to approach more nearly to the rank of a certain sign than any one group of the symptoms of pregnancy enumerated in this section as occurring during the first trimester. Schroeder,[1] indeed, goes so far as to say: "The pregnant uterus is so characteristically soft, almost dough-like, from the second to the fourth month that in cases in which this change is present in a pronounced degree pregnancy is positively demonstrated."

Upon looking over the various phenomena which appear during the first trimester, it is evident that not one symptom or group of symptoms, considered in itself, constitutes, strictly speaking, a certain sign of pregnancy. There is not one upon which, in the absence of all others, the fact of pregnancy may be positively predicated. All the signs hitherto discussed afford more or less highly probable evidence. Nevertheless, the evidence cumulative from all these symptoms is amply sufficient in the large majority of cases to enable the expert observer to build up by synthesis a diagnosis of such a high degree of probability as to vary from an absolutely positive diagnosis by less than any assignable difference just before or at the expiration of the first three months. "If," says Schroeder,[2] "the uterus is found, upon bimanual exploration, of a size corresponding to the period of time (end of the third month), in a position of slight anteflexion, non-sensitive, of a peculiar consistence—if the woman is perfectly healthy, and if the previously regular function of menstruation has been suppressed for a corresponding period of time—the diagnosis of pregnancy is certainly established."

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[1] *Lehrb. d. Geburtsh.*, 9te Auflage, Bonn, 1886, p. 109.

[2] *Loc. cit.*, p. 110.

### II. SECOND TRIMESTER.

1. SUBJECTIVE SIGNS.—The morning sickness commonly disappears spontaneously between the third and fourth months, and, in general, a subsidence of the so-called sympathetic disorders is observed during the second trimester.

2. OBJECTIVE SIGNS.—*Changes in the Mammæ.*—The mammary changes become more pronounced. The secondary areola makes its appearance in women with dark hair and eyes about the fifth month. Lineæ albicantes are seen in cases of considerable mammary development. The occasional shrinking in the volume of the breasts about the fourth or fifth month in the absence of any apparent cause has been mentioned. At the end of this period the changes in the mammæ usually constitute a certain sign of pregnancy in primiparæ.

*Intermittent Uterine Contractions.*—Tyler Smith, among others, has described the peristaltic action of the uterus during pregnancy. Braxton Hicks, in a communication to the London Obstetrical Society in 1871, called attention to the fact that during the entire period of gestation the uterus contracted and relaxed at intervals usually varying from five to twenty minutes, and to the value of these phenomena in the diagnosis of normal and complicated pregnancy. Usually the duration of each contraction is from three to five minutes. These alternations in density seldom become sensible before the end of the third or the middle of the fourth month, and even then the flaccid state is often so complete that the sensation of all resistance is lost, except to very careful bimanual examination.[1] To elicit this sign before the end of the fourth month it is necessary to practise bimanual palpation. After this period the hand is placed upon the lower abdomen, and the woman, in the recumbent position, is made to breathe deeply and freely. During expiration the uterine tumor can be outlined and the intermittent uterine contractions readily perceived.

Braxton Hicks[2] has pointed out the alterations these contractions make on the respiratory wave of the abdomen. Then they produce important effects, especially during the latter weeks of pregnancy and the beginning of labor. During a contraction the uterus becomes anæmic. Braune's plane frozen sections show that the vessels of the walls of the uterus caught in diastole are filled with blood; when caught in systole the vessels are empty. Two important functional changes result. The blood, surcharged with carbonic acid, is displaced, and a renewal of the circulating fluid is permitted. The blood, squeezed out of the uterus, first distends the capillaries of the adjacent vascular areas of the cervix and vagina. A serous exudation occurs, resulting in softening of these structures and increased mucous secretions—changes having an important influence upon the process of labor. These phenomena constitute what has been termed "vital dilatation."

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[1] J. Braxton Hicks: "On the Contractions of the Uterus throughout Pregnancy, and their Value in the Diagnosis of Pregnancy, both Normal and Complicated," *Transactions of the Ninth International Medical Congress*, 1887.

[2] "Note on the Auxiliary Forces concerned in the Circulation of the Pregnant Uterus in Woman," *Proceedings of the Royal Society*, No. 195, 1879.

The only morbid states at all likely to simulate these contractions are hæmatometra and soft uterine myomata. The distended bladder is not worthy of serious consideration, since its evacuation ought to be insisted upon before any attempt is made to elicit the sign. In hæmatometra the peristaltic action of the uterus is very feeble and seldom perceptible. In cases of collections of blood within the cavum uteri the walls of that viscus are passively distended and do not undergo any appreciable hypertrophy. The exclusion of such tumors, as a rule, is accordingly possible.

But in rapidly-growing soft fibroids the differential diagnosis is usually difficult, and sometimes impossible. The contractions in soft myomata are usually the result of manipulation, and do not possess the same constant and spontaneous character as those of the pregnant uterus. Repeated examinations, with precautions against needless manipulation, usually clear up the obscurity in diagnosis.

Diagnostic value of a high degree must be attached to this sign. It is always present, and is usually perceptible early in pregnancy. It is completely independent of the life of the child, being observed in cases of degeneration of the ovum and of retention of the dead fœtus within the cavum uteri. In the pregnant uterus, with foci of myomatous tissue, the alternations of density in the normal musculature can be felt, while the consistence of the fibroids undergoes no sensible change. The assertion has been made that the presence of these intermittent uterine contractions demonstrates the normal or intra-uterine character of the pregnancy. This statement is not strictly accurate. In ectopic gestation of the abdominal variety an adventitious uterus is usually developed, which is composed of the same morphological elements as the normal uterus. On *a-priori* grounds there is every reason to believe that intermittent contractions occur in this adventitious uterus, just as they do in the normal organ. They are, however, probably more feeble.

The sign is of very great value in cases of hydramnios. When the excess of liquor amnii is great, and the fœtus too small to give signs of its life, the resemblance of the uterine tumor to an ovarian cyst may become very close. Charpentier[1] cites a case coming under his own observation of rapid abdominal enlargement in a woman whose menstruation had been suppressed for three months. No modifications of the vaginal portion were perceptible, and other possible signs of gestation were masked by a grave thoracic disease. The diagnosis was null until on palpation alternations in the density of the tumor were noted, when the condition of acute hydramnios in the third month of pregnancy was recognized. Pregnancy was at once artificially interrupted, and twin fœtuses corresponding to the twelfth week were removed from the cavum uteri, together with fifteen liters of fluid.

Braxton Hicks has recently described a peculiar condition of the gravid womb in which, at about the fifth month, the uterus is very flaccid—"scarcely to be felt except at one part, where a firm lump is to be felt"—during the interval between contractions. This condition he finds very often associated with the death of the fœtus. The diagnosis under these conditions lies between simple pregnancy, pregnancy complicated by a tumor, and ectopic gestation. If the hand is placed upon the womb until that organ contracts, the whole mass is transformed into a solid ball. The more solid portions merely mark the position of the placenta.

Lawson Tait[2] declares that "this is an infinitely more certain sign than the fœtal heart or the sound of the placental bruit." Now, as at present informed, no such sound as the placental bruit exists in nature, and the literal significance of Mr. Tait's words amounts to an absurdity. Still, we may construe the sentence as a figurative expression for the great value attached by the speaker to this sign. The deliberate opinion of such an observer of enormous experience is justly entitled to a high degree of consideration.

Inasmuch, however, as the intermittent uterine contractions are closely simulated by at least one morbid state, more particularly during the early months, the symptom cannot be classified among the certain signs of pregnancy.

*Active Fœtal Movements.*—The sensation communicated to the mother by the spontaneous movements of the fœtus is popularly known as "quickening," since it was formerly erroneously thought that at this time life was imparted to the embryo. Active fœtal movements are usually first felt by the mother—suddenly in very many cases—about the sixteenth week, the time varying within wide limits, although they really commence at a very early period of embryonal life—as soon as the muscular tissue is developed sufficiently to contract. It is generally believed that the maternal recognition of the phenomena depends upon the contact of the uterine tumor with the anterior abdominal wall and the transmission of the fœtal impulse through the sensory nerves. The sensation, when first experienced, is commonly described as being like the feeble fluttering of a bird held in the closed hand. As pregnancy advances the movements become more manifest, consisting of a series of short, sharp strokes or kicks, which often give origin to unpleasant sensations and even positive pain, more particularly in primiparæ of highly nervous temperament. Palpation under favorable conditions enables the examining physician to detect fœtal movements at the end of the twelfth week, long before the mother feels them. As gestation proceeds these active movements may be heard and even plainly seen. Prior to the fourth month the sign may be occasionally elicited upon bimanual palpation or vaginal stethoscopy; after this period by abdominal palpation. The anecdote is related of the late Charles Budd of New York that upon meeting several eminent physicians in consultation over an obscure case of abdominal enlargement, he placed his hand on the cold window-glass and then gently applied it to the patient's naked belly. Immediately he felt a series of short, sharp strokes, and the diagnosis was at once cleared up. The story affords a valuable hint in practice. Sometimes, however, the sudden impression of cold causes rapid contractions of the abdominal walls or of the uterus, obscuring the sign. The movements consist in flexions and extensions of the trunk and upper and lower extremities.

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[1] *Transactions Ninth International Medical Congress.*

[2] *Transactions of the New York State Medical Association*, Albany, 1886.

The causation of the spontaneous movements of the fœtus is not definitely known. Braxton Hicks is of the opinion that there is some closely constant relationship between the highly carbonized blood-accumulation in the uterine veins and the fœtal movements, and between the fœtal movements and the intermittent contractions of the uterus. Their force and frequency vary greatly in different individuals, and in the same individuals at different periods of the day. Usually, they are more manifest upon rising from bed in the morning. It is certain that their force and frequency increase after prolonged abstinence from food and just prior to death from asphyxia. Certain positions of the body also seem to influence these manifestations. From being very active, they may cease entirely for days at a time, and still the fœtus may be in a perfectly physiological state. Sudden and complete cessation of all movements is often coincident with the death of the child. The sudden and complete cessation of these phenomena, however, is also observed as the result of the operation of unknown causes which do not affect the vitality of the child. Many cases are recorded in which the movements have never been perceived by the mother nor felt by the medical attendant, and yet perfectly healthy children have been borne (Mauriceau, De la Motte, Cazeaux, Fouquier, Campbell). It has been suggested that the movements actually occurred during sleep, and were not brought to the maternal consciousness.

Certain pathological conditions may interfere with the perception of the fœtal movements, both by the mother and the physician. Thus, in hydramnios and ascites their recognition is usually difficult and occasionally impossible.

Viewed as a subjective symptom, quickening as a sign of pregnancy is liable to many and essential fallacies. Irregular contractions of the abdominal muscles, the peristaltic action of the intestines—particularly when distended with gas—a wandering kidney, cause sensations which the woman so frequently interprets as being of fœtal orgin that little diagnostic significance attaches to her perception. The symptom, however, has a limited value as sometimes furnishing one of the data upon which the day of confinement may be predicted.

When felt—and especially when seen and heard—by the expert observer, the active movements of the fœtus constitute a sign absolutely diagnostic both of pregnancy and of the life of the child. No normal or abnormal state of the abdominal muscles nor of the abdominal viscera imparts to the hand at all experienced in palpation sensations that can easily be confounded with active fœtal movements. Their absence, however, does not demonstrate that pregnancy does not exist nor that the fœtus is not alive.

*Passive Fœtal Movements.*—Movements may be communicated to the fœtus surrounded by the liquor amnii, and its passive reaction often constitutes a valuable sign of pregnancy. These passive fœtal movements are technically known as the phenomena of ballottement or repercussion. The sign is generally available from the fourth to the eighth month. Before this period the fœtus is relatively too small and the uterine walls too thick; after the eighth month the fœtus is relatively too large to float upward in the normal quantity of liquor amnii. Exceptionally, the sign can be elicited as early as the middle of the fourth month. Passive movements of portions of the fœtal body may be perceived up to the time of engagement of the presenting part within the pelvic inlet.

According as the phenomena of repercussion are elicited by vaginal exploration or by abdominal palpation we have the methods of internal and external ballottement. The former is much the more valuable of the two as regards diagnosis, inasmuch as it can be successfully practised before the uterus constitutes an abdominal tumor of considerable size. The latter method is occasionally applied in the differential diagnosis of large abdominal swellings.

To practise internal ballottement, the woman is placed in the lithotomy position, and the index finger, or two fingers, of the right hand are applied to the anterior vaginal wall at the plane of the junction of the cervix with the corpus uteri, while the left hand gently presses the fundus downward. The intravaginal finger suddenly and quickly presses from below upward and from behind forward the anterior uterine wall in the direction of its long axis. The entire body of the fœtus is thus displaced, floating upward until it reaches the fundus, when its impact may be felt by the left hand. The recession of the mass—usually the head—filling the lower uterine segment is perceived by the intravaginal finger. In a moment the return tap of the presenting part is felt. Depaul lays particular stress upon the sensation imparted by the departure of the head from its customary resting-place, and attaches less significance to the *choc en retour* which Pajot especially emphasizes. As remarked by Charpentier,[1] Depaul practises cephalic ballottement, while Pajot displaces upward the entire body of the fœtus.

In external ballottement the woman is placed upon her back, and the two hands are applied to the opposite sides of the uterus. Then a sudden, quick stroke of one hand displaces the body of the fœtus toward the other hand, just as a lump of ice floating in a glass of water is displaced by a tap with the finger. Or the woman may be placed in the lateral position, with her belly overhanging the edge of the bed. One hand is placed upon the upper side of the uterus, while the fingers of the other hand rest upon the lower side. The sensation of the recession of the fœtal body and the *choc en retour* are more distinctly perceived in this position than in the former.

It is difficult—sometimes impossible—to elicit ballottement by the vaginal method when the fœtus is abnormally large or very small, in cases of excess and deficiency of the liquor amnii, in placenta prævia, in multiple pregnancy, and in pelvic and transverse presentations.

The fallacies to which the sign is liable are numerous and not unimportant. A multilocular cystoma of the ovary (Pajot), a small ovarian cyst with a long pedicle, the non-pregnant anteflexed uterus (Cazeaux), the pregnant womb itself (Robert Barnes) floating in ascitic fluid, a wandering kidney, a calculus resting in the bas-fond of the bladder (Cazeaux), have actually caused sensations analogous to those of repercussion. It is usually possible, however, to exclude these sources of error.

The sensation of ballottement when elicited by an expert observer may be regarded as a certain sign of pregnancy. However, it affords no information as to the life or death of the fœtus, and its absence does not disprove the fact of pregnancy. Accoucheurs of the Paris school employ the sign more frequently and attach greater diagnostic significance to it than do American, German, and English observers. At the time when the methods of repercussion are capable of application other signs, yielding more adequate information, are commonly present.

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[1] *Traité pratique des Accouchements*, tome i. p. 290, Paris, 1883.

*Palpation of the Fœtal Body.*—In the abdominal palpation incident to the discovery of intermittent uterine contractions, the active and passive movements of the fœtus, and the like, it is often possible to directly outline the entire or various portions of the fœtal body during the intervals between the painless contractions of the womb. Thus, the head is sometimes felt through the anterior vaginal wall as early as the fourth month.[1] Budin[2] suggests that by pressure on the fundus in cases of longitudinal presentation the normal curvature of the fœtal body is increased and the palpation of the back rendered easier. Attention has already been called to the detection at the fifth month of the placental site by Braxton Hicks.

Many years before the systematic application of abdominal palpation to obstetrical diagnosis Oppolzer called attention to, and happily illustrated in his bedside lectures, the marvellous possibilities in the evolution of tactile sensibility and its general diagnostic utility. The anecdote is narrated of him by one of his former internes (Chrobak) that upon one occasion a patient was brought into his clinic suffering from an obscure abdominal enlargement. Oppolzer seized a portion of the tumor between his fingers, at once pronounced it intestine, and sent the patient to the first surgical clinic to be operated upon for hernia. The woman was speedily returned with the label "Error in diagnosis." He ordered her transferral to the second surgical clinic, whence she was promptly sent back with a like inscription. "But I felt the intestine," remarked Oppolzer; and for the second time she was sent to the first surgical clinic. According to one version of the story, the patient died during this fifth passage between the courts of the Allgemeines Krankenhaus, but the autopsy revealed the accuracy of Oppolzer's diagnosis.

Of course extreme care must be taken in the interpretation of the tactile perceptions now under discussion. Small subserous fibroids of the uterus, carcinomata of the peritoneum and omentum, and multilocular cystomata of the ovaries, especially in the presence of ascitic fluid, may closely simulate to the sense of touch the head, pelvis, and particularly the upper and lower extremities, of the fœtus. While the direct palpation of the entire or portions of the fœtal body seldom furnishes evidence of decisive value, it almost always affords significant corroborative testimony.

*The Fœtal Heart-Tones.*—The sounds of the fœtal heart were accidentally discovered in 1818, two years after the publication of Laennec's memoir on mediate auscultation, by Mayor, a surgeon of Geneva, while trying to hear the sounds supposed to be caused by fœtal movements. Lejumeau de Kergaradec, ignorant of Mayor's discovery, called attention to the same phenomena in a memoir presented to the Paris

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[1] Carl Braun, *loc. cit.*, p. 115.

[2] *Progrès méd.*, 1881, 21.

Academy in 1821. This observer also was led to hear the sounds by accident; he was endeavoring to listen to sounds produced by the liquor amnii.

The fœtal heart-tones are commonly first heard about the eighteenth or twentieth week. Under favorable conditions they may be recognized as early as the fifteenth or sixteenth week, and exceptionally still earlier. Thus, Depaul asserts that he has detected them at the eleventh week; Tarnier, at the twelfth week; Routh and Verardini, by the use of vaginal stethoscopy at the twelfth week.

From the eighteenth or twentieth week they are almost always heard until the expiration of the term of pregnancy. During the last three months Depaul failed to hear them in only 8 out of 906 cases; Anderson of Glasgow, in only 12 out of 180 cases, and in all of these 12 cases the children were stillborn.

The quality of the tones is usually described as being like the tick-tack of a watch heard through a pillow. A more adequate notion, however, is easily acquired by listening to the heart-tones of a newborn child. The sound is dicrotic; the first tone, being loudest and strongest, corresponds to the ventricular systole; the second is sometimes inaudible. A very short interval of time elapses between the first and second tones, but between the second and the succeeding first tone there is a distinct pause. The cardiac cycle, so far as the tones are concerned, may be graphically represented by: tick—tack—pause.

The force of the heart's action under normal conditions seems to undergo no alteration from the time it is first heard until the expiration of the period of gestation. At the eighteenth or twentieth week the intensity of the heart-tones, subject to individual variations, is as great as at term. The distinctness with which the tones are heard in the individual case depends upon the size and development of the fœtus, the intimate relationship between the thorax and the uterine wall, the thinness of the uterine and abdominal parietes, the quantity of the liquor amnii, and the like.

The frequency of the heart's action varies within physiological limits from 120 to 160 beats to the minute. The factors which accelerate or diminish the frequency of the heart's action include numerous maternal and fœtal conditions, both normal and morbid. Active and passive movements of mother and child quicken the heart-beats. When the blood in the uterine sinuses becomes surcharged with carbonic acid, as in asphyxia, the heart-beats are at first somewhat accelerated, but soon become slow and increased in force. Winckel, Runge, and others have shown that any elevation of maternal temperature is followed by a disproportionately great acceleration of the action of the fœtal heart. Specific poisons contained in the maternal blood, as in smallpox, have an important effect. Chloroform, inhaled by the mother, passes into the fœtal blood and acts directly upon the cardiac muscle. Ergot, by causing a tetanic spasm of the uterine musculature, produces the alterations in the frequency of the heart-beats characteristic of asphyxia. During a normal uterine contraction the heart's action is accelerated in the phases of increment and decrement, but slowed during the acme, in part the result of increased blood-pressure. These phenomena are especially apparent after rupture of the bag of waters. In morbid states of the fœtal envelopes, compression of the umbilical cord, partial separation of the placenta, and the like, the alterations in the frequency of the heart-beats are chiefly those of asphyxia.

Frankenhäuser[1] in 1859 asserted that the sex of the child exerted an important influence on the frequency of the heart's action, and that the average rate of pulsation is less considerable in male than in female children. In 50 cases this observer found the average rate to be 124 in males and 144 in females. Dauzats found that when the pulsations were above 145 the child was generally a female; when less than 135, a male; when 135 to 144, the sex was uncertain. Frank C. Wilson[2] of Louisville is of the opinion, derived from extensive observation, that the sex of the child can be predicted with a reasonable degree of accuracy from the rapidity of the fœtal heart-sounds. He has found these to vary within normal limits from 110 to 170, and that "134 may be taken as the dividing-line above which the sex will be female, and below which the sex will be male, the certainty increasing the farther you recede from the dividing-point." This observer has constructed the following table:

From 110 to 125 the sex will be, almost certainly, male.
" 125 to 130 " " probably, male.
" 130 to 134 " " doubtful, with chances in favor of male.
" 134 to 138 " " doubtful, with chances in favor of female.
" 138 to 143 " " probably, female.
" 143 to 170 " " almost certainly, female.

Steinbach and Devilliers fix the average rate at 131 in males and 138 in females. Cumming,[3] Devilliers, and others conclude, however, that the difference in the rate of pulsation is determined chiefly by the size and development of the fœtus, "so that a large female child may have a slower pulse than a small male."

Engelhorn[4] is of the opinion that the frequency of the fœtal heart-beats diminishes with the increase in length of body. Volkmann's tables render this statement highly probable in the case of adults. Engelhorn's averages were as follows:

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[1] *Monatschr. f. Geburtsh.*, Bd. xiv. p. 161.

[2] Parvin: *The Science and Art of Obstetrics*, Philada, 1886, p. 192.

[3] *Edin. Med. Journ.*, 1875.

[4] *Arch. f. Gyn.*, Bd. ix. p. 368.

| Body-length. | Frequency of the fœtal heart-beats. |
|---|---|
| 40–45 cm. | 147.9 |
| 45–50 cm. | 137.9 |
| Above 50 cm. | 126.6 |

The results of the researches of Budin[1] and Chaignot are of peculiar interest and value in this connection. Their conclusions are based upon the examination of 70 cases of normal pregnancy a few weeks before term. Male children were born in 41 cases, female in 29. The conclusions are, briefly—

1. There is no absolute relation, from a practical point of view, between the number of fœtal heart-beats and the sex of the infant. High and low numbers are found as well with the one as with the other. Least of all is there ground for the prediction of the sex of the fœtus when the number of pulsations is low; that is to say, 130 to 140.

2. If the heart-beats are counted at different times during the latter months of pregnancy, sometimes about the same number is found, but more frequently a different number is recognized at each examination. For example, in the same fœtus we have found—30th November, 160; 8th December, 138; 12th December, 128; 14th December, 134.

3. Moreover, sometimes, while the woman is remaining perfectly immobile in the horizontal position and the observer has his ear applied to the stethoscope without moving, one finds variations in the number of pulsations in successive minutes of from 15 to 25, without being able to find a cause for these variations. To such a degree is this the case that it is sometimes embarrassing to determine exactly what is the mean rate.

4. There is no foundation for the alleged relation between the weight of the child and the frequency of the heart's action. A large number of pulsations to the minute does not indicate a small fœtus, and a small number of pulsations a large fœtus. In proof we offer the following figures, the boys and the girls having been placed in the order of their weights:

| | | | | |
|---|---|---|---|---|
| Boys: | the smallest | 2.175 | grammes, | 132 pulsations. |
| | the largest | 4.210 | " | 144 " |
| Girls: | the smallest | 2.008 | " | 128 " |
| | the largest | 3.650 | " | 140–150 pulsations. |

When we regard merely the extremes, it would seem that conclusions ought to be arrived at the inverse of those formulated by Cumming. But we hesitate to do this: the intermediary observations present such a variety that we believe there is no relation between the weight of the fœtus, the heart-beats, and the sex.

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[1] P. Budin: *Obstétrique et Gynécologie*, Paris, 1886, p. 217.

To elicit the average rate of pulsation of the fœtal heart it is necessary that the perfectly healthy woman be placed in the horizontal position, that she remain as immobile as possible, and that auscultation be practised in the intervals between uterine contractions and in the absence of active and passive fœtal movements. These conditions were all fulfilled in the researches of Budin and Chaignot. They are accordingly entitled to a very high degree of consideration, and may be accepted as conclusive for the time being. The subject is well worthy of further investigation.

While, of course, the prediction of sex is a matter of comparatively trivial moment so far as practice is concerned, its physiological significance is considerable. Moreover, adequate conceptions of the normal and abnormal variations in the force and frequency of the action of the fœtal heart are of the greatest practical consequence in the determination of the time for operative interference during pregnancy and labor. Any contribution to our knowledge of the causes which affect the functions of the fœtal heart, however apparently trivial or irrelevant, is significant. Kilian in 1849 formulated what is sometimes called "the stethoscopical indication for the forceps operation:" "The forceps must be applied under favorable conditions without delay when the fœtal heart-tones diminish in frequency to less than 100 to the minute, or when they increase to 180, and when at the same time they lose their purity of tone, when distinct intermissions occur, and when only one tone can be clearly heard."

Mediate or immediate auscultation may be employed in the examination of the fœtal heart-tones. Mediate auscultation is preferable, for perfectly obvious reasons. But unless the obstetrician has had large experience with the stethoscope in listening to the fœtal heart-tones, he will find the direct application of the ear to the belly of the woman a more speedy and reliable method. In the choice of a stethoscope the practitioner will be governed by the instrument he is accustomed to employ in the physical exploration of the chest. The binaural stethoscope has certain advantages over the monaural instrument, but muscular sounds are more apt to create confusion. The stethoscope should be provided with a wide bell.

Early in pregnancy the stethoscope should be applied over the fundus in the line of the axis of the pelvic inlet, and subsequently the entire anterior surface of the uterus may be explored. During the last three months palpation usually reveals the presentation and position of the fœtus, and indicates approximately the cardiac area. The space over which the heart-beats are heard with the maximum intensity is commonly limited, being six or eight centimeters in diameter. In exceptional cases they are heard over the whole anterior uterine surface. Two areas of maximum intensity on opposite sides of the median line, with a difference in the frequency of the pulsations, are strongly presumptive of twin pregnancy. In first positions of the vertex the heart-tones are usually heard to the left of the linea alba, at about the middle of the line drawn from the umbilicus to the centre of Poupart's ligament; in right occipito-posterior positions, to the right of the linea alba, a little to the outer side of the middle of the line between the umbilicus and the centre of Poupart's ligament. In pelvic presentations the heart-tones are heard above the plane of the umbilicus, to the left or right of the median line according to the direction of the child's back. Depaul explains the fact that in cephalic presentations the heart-tones are heard below, and in pelvic presentations above, the plane of the umbilicus, upon the hypothesis that the heart is situated nearer to the cephalic than to the pelvic extremity. Ribemont, however, has demonstrated, by the plane frozen sections of fœtuses of various ages, that the heart is about equidistant from the pelvic and cephalic poles of the fœtal ovoid. Hennig[1] attaches some importance to the cranial bones, as being better conductors of sound than the fœtal pelvis.

The true explanation is to be found in the engagement of the cephalic extremity within the pelvic inlet during the last weeks of gestation. In pelvic presentations this engagement does not occur until immediately before or during labor, so that the fœtal heart remains at a higher plane. In case of excessive size of the head, prolapse of an extremity, pelvic contraction, placenta prævia, the head may not engage in the inlet during the latter weeks of gestation, and the fœtal heart-beats are often heard at or above the plane of the umbilicus. In left mento-anterior positions of face presentations and dorso-posterior positions of transverse presentations, on account of the intimate relationship between the walls of the uterus and the thorax and the transmission of the sounds through the anterior instead of the posterior chest-wall, the heart-tones are heard with extraordinary distinctness, and have even been felt by the finger of the examiner in exceptional cases.[2]

Maygrier suggested, and Nauche actually constructed, a vaginal stethoscope under the name of metroscope. This instrument, applied either to the vaginal vault or within the cervical cavity, fell into disuse, partly on account of the alleged violence to the parts. In recent years Verardini (1878) of Bologna has successfully practised intravaginal stethoscopy, without endangering the product of conception, as early as the twelfth week. In the event of failure to hear the pulsations of the fœtal heart repeated trials must be made on different occasions, and their absence or disappearance alone never justifies the assumption that the fœtus is necessarily dead.

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[1] *Zeitschr. f. Geb. u. Gyn.*, Bd. xi. p. 47.

[2] Fischel: *Prager med. W.*, 1881, Nos. 12, 28; Fleischmann: *Ibid.*, 1885, No. 35; Valenta: *Ibid.*, 1885, No. 45.

The only sounds that closely simulate the fœtal heart-tones are the maternal heart-tones, transmitted through the uterine tumor. Under normal conditions these are so much less frequent that the counting of the number of pulsations to the minute commonly suffices to clear up any obscurity in diagnosis. In case of elevation in temperature the acceleration in the frequency of the action of the maternal heart renders the differential diagnosis more difficult. However, if the suspected sound originates in the maternal heart, it will increase in intensity as the præcordial region is approached.

The clear and distinct recognition of the fœtal heart-sounds is an absolutely certain sign both of pregnancy and of the life of the fœtus. Their absence, however, does not warrant the assumption that pregnancy does not exist or that the child is dead. Alterations in the force, and especially in the frequency, of the heart's action afford important information as to conditions which threaten the child's life. Finally, the site at which the heart-tones are heard with maximum intensity is of great value in the diagnosis of presentation and position, as originally pointed out by De Kergaradec.

*The Fœtal Souffle.*—The fœtal souffle is a single or double, blowing murmur isochronous with the fœtal heart-beats, heard at or near the area of maximum intensity and in various other widely-removed regions of the uterus. According to the researches of Hecker[1] and Schroeder,[2] it occurs in 14–15 per centum of all cases. In many cases the sound originates within the fœtal heart, and is known as the cardiac souffle. It has been demonstrated to be due to hypertrophy of the right ventricle, with insufficiency of the tricuspid and mitral valves and vegetations (Virchow), perforation of the ventricular septum (Massmann, Carl Braun), passage of blood through the foramen of Botal, and to various functional disturbances (Scanzoni, Skoda, Bumm). In other cases the sound is produced within the umbilical cord, and is termed the funic souffle. By Evory Kennedy, who discovered it, Naegele, Depaul, Devilliers, Charrier, and others it has been regarded as due to mechanical interference with the circulation in the cord. Kehrer[3] succeeded in producing a systolic murmur by compression of the cord with the stethoscope in a case in which the funis was palpable between the fœtal body and the wall of the uterus.

Pinard[4] and Bumm[5] think the sound is caused by the diminution of the lumina of the umbilical vein and arteries through the hypertrophy of the semilunar valves described by Hyrtl and Berger. The funic souffle is a single, sometimes double, murmur of variable quality and intensity, fugacious, and usually heard at some distance from the area of maximum intensity of the pulsations of the fœtal heart.

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[1] *Kl. d. Geb.*, p. 27.

[2] *Schw. Geb. u. Wochenbett*, p. 17.

[3] *Arch. f. Gyn.*, xii. p. 258.

[4] *Arch. de Tocol.*, 1876, p. 310.

[5] *Arch. f. Gyn.*, Bd. xxv. p. 277.

Both sounds are absolutely diagnostic of pregnancy and of the life of the child, but neither sound constitutes an indication for operative interference. Charrier, indeed, regarded the funic souffle as a sign of impending asphyxia and as being an indication for the induction of premature labor. However, inasmuch as children are born with the cord so coiled around such parts as to be subject to compression, without the production of this sound, and still others in whom the sound was present are born with the cord in its normal relations, the indication for the induction of premature labor is not at all apparent. Winckel[1] insists upon the careful observation during labor of the cases in which the funic souffle is present, and upon early operative interference in the event of changes in the fœtal heart-tones.

*Sounds due to Active Fœtal Movements.*—Pajot in particular has studied the auditory and tactile sensations produced by active fœtal movements. At the end of the third month a bruit is produced comparable to the sound caused by tapping the finger against a tense membrane. This sound is the result of the total displacement of the fœtus. Toward the end of gestation the bruit is caused by partial movements, as of the extremities and head. It is then localized at the fundus. To these sounds Pajot has given the term *bruit de choc fœtal.* If the stethoscope be applied over the uterus during active fœtal movements, two phenomena are perceived—a quick but exceedingly delicate bruit, and the sensation of shock from the impact of the fœtus or its extremities against the uterine walls. The ear, struck at the same time in its general and special sensibility, receives at once a tactile and an auditory impression.

As an early sign of pregnancy the sounds are of diagnostic significance to the skilled observer. Later, they are merely interesting auscultatory phenomena.

*The Uterine Souffle.*—Of all the maternal bruits, the uterine souffle is of chief moment. This sound was discovered by De Kergaradec in 1821, who termed it *battement simple avec souffle.* Since that time it has been successively designated placental souffle (Monod, Ulsamer, Hohl), abdominal souffle (Bouillaud), simple pulsation (Ritgen), epigastric souffle (Kiwisch), uterine souffle (P. Dubois, Depaul, Naegele).

The uterine souffle is subject to many individual variations as regards quality, intensity, rhythm, and the site of maximum intensity. In quality it is commonly a blowing, sibilant murmur, like the bruit of a varicose aneurism. In other cases it is a soft murmur, comparable to the sound produced with the lips in pronouncing in a low voice the syllable *vous* (Depaul). The sound increases in intensity until the eighth month, and then remains stationary. According to Depaul, it sustains no relation to the intensity of the sounds of the maternal heart, but is lessened by all causes that effect a diminution in the calibre of the uterine blood-vessels, as strong pressure with the stethoscope, active fœtal movements which compress the uterus, and uterine contractions. During a uterine contraction the souffle increases in intensity in the phases of increment and decrement, but becomes almost imperceptible in the acme. As regards rhythm, the bruit is usually single and intermittent, sometimes dicrotic and continuous. It is isochronous with the maternal pulse, and is thus readily distinguished from the funic souffle, which it closely resembles in other particulars.

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[1] *Zur Path. d. Geb.*, p. 223.

The site at which the uterine souffle is heard with maximum intensity varies in different individuals and in the same individual on different occasions. It is most frequently heard with greatest distinctness low down and to one or other side, sometimes over the fundus, very seldom over the entire anterior uterine surface. Out of 80 cases observed by Jacquemier, it was more or less limited to the left iliac region in 34, to the right in 22, to the umbilical region in 4, over the anterior uterine surface in 9. Out of 395 cases of pregnant women who had passed the fifth month, observed by Depaul, the bruit was distinctly heard on each side of the uterus in 182 cases, on only one side in 27, over the fundus in 43, over the anterior uterine surface in 18, in three distinct places—over both sides and over the fundus—in 12.

The uterine souffle is commonly first heard at the end of the sixteenth week, although Kennedy, Carrière, Depaul, and Verardini have detected it as early as the tenth or twelfth week.

The causation of this souffle has been productive of numerous suppositions, of which the placental, iliac, epigastric, and uterine hypotheses are especially worthy of consideration.

1. *Placental Hypothesis.*—Laennec, Carrière, Monod, Hohl, and others localized the maternal souffle in the placenta. Hohl thought the sound was the result of the passage of the arterial blood into the placental venous sinuses. Bailly, however, has shown that the souffle persists, in nine out of ten cases, after the expulsion of the placenta for an average period of sixty-three hours. In one case it persisted six days. Bailly's observations have been abundantly confirmed.

2. *Iliac Hypothesis.*—The supposition of Haus, subsequently adopted by Bouillaud, is that the sound has its origin in the aorta and iliac arteries, and is caused by the mechanical pressure of the gravid uterus. Lahs, however, has shown that the pressure of the gravid uterus in the intervals between contractions is practically but little greater than the normal superjacent intestinal mass. The souffle has been heard as early as the twelfth week, before the uterus is high enough in the abdomen to effect mechanical compression. The irregular character,

occasional disappearance, and variable site of the souffle render this supposition highly improbable. The sound disappears during the acme of uterine contraction, instead of increasing, as it would in case of localization in the aorta and iliacs. Finally, Tarnier[1] by pressure with the stethoscope has caused the disappearance of the abdominal souffle without affecting the bruit in the femoral artery. These considerations totally invalidate the iliac hypothesis.

3. *Epigastric Hypothesis.*—Kiwisch and Glénard advocated the view that the sound was generated in the epigastric artery. Glénard asserted that compression of the epigastric caused a modification, and ultimately the disappearance, of the souffle. Tarnier replied that such a degree of compression was sufficient to compress the uterine artery also. Glénard then abandoned his hypothesis, and referred the sound to the puerperal artery, an anastomotic branch connecting the uterine and ovarian artery —a virtual reversion to the uterine hypothesis. Hecker[2] detected a systolic bruit in the epigastric in a pregnant woman. It cannot be denied that in certain exceptional cases extra-uterine murmurs are heard, but they do not closely simulate the uterine souffle.

4. *Uterine Hypothesis.*—P. Dubois localized the abdominal souffle in the walls of the uterus. This hypothesis is in harmony with the variations in quality, intensity, rhythm, and site of maximum intensity already mentioned. All the physical conditions essential to the production of such a sound are present—the tortuous parietal branches of the arteries, of greater calibre than their parent trunks; the termination of arteries in the venous sinuses, especially near the placental site; the *mélange* of rapidly-moving columns of red blood with the slowly-circulating venous blood. Finally, actual vibrations of the uterine arteries can be felt and heard per vaginam.[3] In exceptional cases the vibrations may be felt through the abdominal walls.[4]

The uterine origin of the abdominal souffle may be accordingly regarded as demonstrated, although the exact mechanism of its production is still the subject of controversy. Thus, Depaul is of the opinion that the compression of the uterine arteries by the active fœtal movements plays an important rôle. These active fœtal movements probably sustain some important relation to the intermittent uterine contractions, as pointed out by Braxton Hicks. Cazeaux and Scanzoni attach much significance to the qualitative changes in the blood of the pregnant woman.

The diagnostic value of the uterine souffle is very greatly impaired by the fact that a closely similar bruit is sometimes heard in chronic metritis, frequently in uterine myomata, and occasionally in ovarian cystomata. The sign yields no information as to the intra-uterine location of the fœtus, as affirmed by Depaul, since Schroeder and Rizzole[1] detected the souffle in the adventitious uterus of ectopic gestation.

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[1] Tarnier et Chantreuil: *Traité de l'Art des Accouchements*, p. 503.

[2] *Klinik der Geb.*, 1871, p. 31.

[3] Rapin: *Corresp. Bl. f. Schweizer Aerzte*, ii. 2.

[4] Rotter: *Arch. f. Gyn.*, Bd. v. p. 539.

It affords no information as to the life of the fœtus. At best, it is merely a presumptive sign, of a certain value on account of its early and almost constant occurrence.

During the second trimester the uterine tumor assumes the form of a short ovoid or of a flattened spheroid. At the end of the fourth month the fundus is about 5 cm. above the pubes; at the end of the fifth month, about 5 cm. below the umbilicus; at the end of the sixth month, on the same plane or slightly above the umbilicus. During this period the umbilical depression grows gradually less, until at the expiration of the sixth month it is on the same level with the cutaneous surface of the abdomen or is even slightly everted. Lineæ albicantes begin to appear toward the close of the second trimester.

The vaginal portion continues to grow softer from below upward. According to Tarnier, in the primipara the lower half is softened at the end of the sixth month. At that time it is situated to the left of the median line, high up in the pelvic cavity, in the vicinity of the left sacro-iliac joint. In some cases it is situated at or even above the plane of the inlet.

The varices and œdema of the vulva and lower extremities are augmented as the result of increased intra-abdominal pressure.

### III. Third Trimester.

During the third trimester all the objective changes heretofore described in connection with the mammæ and the genitalia are intensified.

At the end of the seventh month the fundus extends about 5 cm. above the umbilicus; the average circumference of the abdomen in the region of the navel measures 91 cm.; midway between the navel and the symphysis, about 94 cm.; the average distance between the xiphoid process and the pubes is 42 cm. (Schroeder). The vaginal portion in primiparæ is softened in its lower three-fourths. The cervical canal, closed in primiparæ, is frequently pervious for the index finger in multiparæ.

The head may usually be felt in primiparæ, occupying the lower uterine segment.

At the end of the eighth month the fundus is about 5 cm. below the ensiform process. The average circumference of the abdomen in the region of the umbilicus measures 95 cm., midway between the navel and the symphysis, 97 cm.; the average distance between the ensiform process and the pubes is 43½ cm. The abdominal walls are tense in the primipara, and the umbilical ring is slightly convex. The entire vaginal portion in primiparæ is softened, and the head is felt above the inlet just about to engage.

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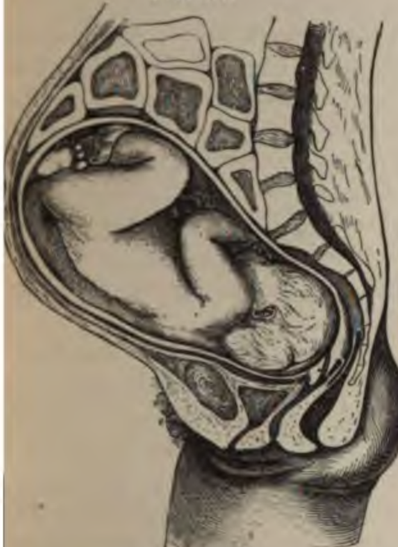
[1] *Ann. d. l. Soc. Méd. Disc. de Liège*, 1880.

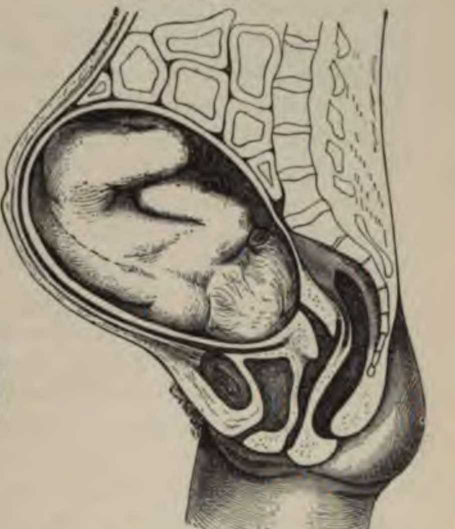
At the end of the ninth month the fundus has attained its highest elevation, near the ensiform process. The average circumference of the abdomen in the umbilical region measures 97½ cm., midway between the navel and the symphysis, 99 cm.; the distance from the ensiform process to the symphysis is 44 cm. The umbilicus becomes more convex. The os externum in primiparæ is pervious for the terminal phalanx of the index finger; in multiparæ the finger readily passes through the cervical canal to the isthmus of Braun or to the membranes.

FIG. 207.



Schematic Section of a Primipara in the Last Month (Schroeder).

FIG. 208.



Schematic Section of a Multipara in the Last Month (Schroeder).

During the tenth month the lineæ albicantes, which began to form during the latter part of the second trimester, attain their maximum development. The uterus sinks gradually downward during this period, until the fundus is about 8 cm. below the ensiform process, on a slightly lower level than at the eighth month. At the same time, the inclination of the fundus forward is increased, causing augmented protrusion of the anterior abdominal parietes and pouting outward of the umbilicus. Epigastric flattening is evident; the waist becomes smaller, while the lower abdomen is increased in width. The average circumference of the abdomen in the umbilical region measures 99 cm., midway between the navel and the symphysis, 100 cm.; the average distance from the xiphoid process to the pubes is 45½ cm. The time at which this descent occurs is very variable, even in primiparæ. Under normal conditions it usually takes place about two weeks before labor; sometimes, however, it happens early in the tenth month, and often only a day or two before term. In multiparæ this settling down of the uterus is seldom well marked, since, on account of the relaxed condition of the anterior abdominal wall, the organ does not rise so high, and its inclination forward is increased earlier in pregnancy. In these cases it is sometimes difficult to distinguish between the eighth and tenth months. The diagnosis, however, is cleared up by vaginal examination.

The cause of this phenomenon lies in the engagement of the head covered by the lower uterine segment within the pelvic cavity. The symptoms to which it gives origin are of importance, since they constitute the precursors of labor and indicate a normal pelvis. The woman breathes more fully and easily, and frequently notices a subsidence of the gastric disorders arising during the ninth month. At the same time, there is increased difficulty in locomotion, while vesical and rectal disorders are usually present. The pressure-varices and œdema of the vulva and lower extremities receive a sudden increment. On account of the increased ease in respiration and comparative freedom from digestive disturbances, the result of the descent of the gravid womb, the phenomenon has long been popularly known as "the lightening before labor."

An important functional effect to which the phenomenon just mentioned largely contributes is the so-called acute œdema of pregnancy (Wigand). From eight to fourteen days prior to labor the lower uterine segment becomes very soft and œdematous, while the cervical secretions are greatly increased in quantity, preparatory to the dilatation of the remaining portion of the cervix. One factor in this so-called vital dilatation is undoubtedly the intermittent uterine contractions, as already pointed out. But the suddenness of the œdema and its coincidence with the sinking of the womb render the theory highly probable that the serous exudate is in part a mechanical phenomenon, the result of pressure of the fœtal head upon the neighboring veins. This acute œdema of pregnancy may really be regarded as the beginning of labor, as indicated by Lumpe[1] from the study of fifty primigravidæ.

## DIAGNOSIS OF THE TIME OF PREGNANCY AND THE PREDICTION OF THE DAY OF CONFINEMENT.

The exact diagnosis of the time of pregnancy and the prediction of the day of confinement are impossible, for at least two reasons. The *real* duration of pregnancy is the interval between conception and labor, but it is absolutely impossible to arrive at the date of conception, since a variable interval of at least one to fourteen days may elapse between insemination and fertilization. Moreover, it is impossible to determine whether the ovum that is fecundated is the one discharged at the menstrual period preceding coition, or the one corresponding to the first menstrual suppression, or one liberated in the menstrual interval.

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[1] *Arch. f. Gyn.*, Bd. xxvi. Hft. 1, p. 42.

Then the absolute duration of pregnancy in the human female, as in the lower animals, is variable within wide limits. The *real* duration of pregnancy in the human female is accordingly an unknown quantity.[1] Experience, however, teaches that in woman the *average apparent* duration is ten lunar months, forty weeks, or two hundred and eighty days, from the beginning of the last menstruation. The extreme limits, however, are very wide. Schroeder[2] voices a conviction, fully justified by the professional observation of others, in the following words: "I, myself, do not doubt for one moment that a mature child can be born within 240–320 days of the last period."

According to the law in France (*L'article 315 du Code civil*), "the legitimacy of the infant born 300 days after the dissolution of the marriage is liable (*pourra*) to be contested."

In Austria, the law[3] recognizes the legitimacy of the child born within 240–307 days of the death of the father. A jury of experts give their opinion in cases of alleged protracted gestation beyond 307 days. In America and England "the light of the courts in this matter is reflected light. Physicians must determine the matter; and if the space between the minimum and maximum periods hitherto allowed is shown to be too long or too short, the courts will readily follow the truth as it is made manifest."[4]

In the diagnosis of the time of pregnancy and the prediction of the day of confinement in the concrete case we rely upon the following data:

1. *The Date of Fruitful Coition.*—This datum can seldom be determined. In those rare cases of single coition it is supplied. With us in the United States, especially in the large cities, women are frequently able to fix the time at which methods preventive of conception were not employed. Reckoning 272–275 days from the date of fruitful sexual intercourse, the date of confinement can be predicted with a high degree of probability.

2. *The Date of the Commencement of the Last Menstruation.*—"Unquestionably," says Harvey, "the ordinary term of utero-gestation is that kept in the womb of his mother by our Saviour Christ, of men

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[1] See also J. Veit, "Ueber Schwangerschaftsdauer," *Zeitschr. f. Geb. u. Gyn.*, Bd. viii. p. 234.

[2] *Loc. cit.*, p. 85.

[3] *Das k. k. Österreichische bürgerliche Gesetzbuch.*

[4] Wharton: *On Evidence*, sec. 1300.

the most perfect—counting, viz., from the festival of the Annunciation, in the month of March, to the day of the Blessed Nativity, which we celebrate in December. Prudent matrons, calculating after this rule, as long as they note the day of the month in which the catamenia usually appear, are rarely out of their reckoning, but after ten lunar months have elapsed fall in labor, and reap the fruit of their womb the very day on which the catamenia would have appeared had not impregnation taken place." Prof. A. R. Simpson remarks with reference to Harvey's statement, "The dates are derived only from the teachers of the Roman Catholic Church, and when their true meaning is investigated it is found that the 25th of March was held as Lady Day in pagan Rome in honor of Cybele, the mother of the Babylonian Messiah, long before the era of our Lord; while the 25th of December was kept among many Gentile people as the birthday of the son of that 'queen of heaven.'"

In accordance with the notion that the average duration of pregnancy is 280 days from the last menstruation, Naegele[1] devised a ready method of calculating this period from any given date. This method, with slight modifications, has been universally adopted. It consists in counting backward three months from the date of the beginning of the last menstruation, and then adding seven days—in leap-years, after February, six. In February four days, in December and January five days, and in April and September six days only, are necessary to complete the ten lunar months. As women commonly are able to give more accurate information as to the commencement than as to the termination of menstruation, the former date is selected as the starting-point for the computation.

Although, in practice, we rely very largely on this method of the prediction of the day of confinement, the sources of error are numerous and unavoidable. In the more or less periodic morbid discharges of blood from the uterus in early pregnancy and in conception during the amenorrhœa of lactation, disease, and the like, the calculation is impossible. An error in computation of from one to fourteen days, or even greater, earlier or later, is always possible.

3. *The Date of Quickening.*—Quickening is commonly perceived [illegible] the pregnant woman about the sixteenth week, or a short time before the middle of pregnancy—a week later in primiparæ than in multiparæ, according to Ahlfeld. But this sensation is experienced in different individuals at widely varying periods, and sometimes is not perceived at all. Entirely apart from the degree of sensitiveness and on [illegible] attention of the patient, it depends upon the size of the fœtus, the quantity of the liquor amnii, and the like. Still, as a check to other dates, the perception by the woman of active fœtal movements is of definite value.

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[1] *Lehrb. d. Geb.*, viii. Aufl., p. 122.

4. *The Degree of the Alterations in the Uterus.*—The degree of increase in the size of the uterus, as shown by the position of the fundus, the maximum abdominal circumference, and the distance between the ensiform cartilage and the symphysis pubis, affords an approximate datum of a certain value. Schroeder's measurements have already been quoted. Spiegelberg has arrived at the following average altitudes of the fundus:

| | |
|---|---|
| From the 22d to the 26th week, | 24–24.5 cm. |
| In the 28th week, | 26.7 " |
| In the 30th week, | 28.4 " |
| From the 32d to the 33d week, | 29.5–30 " |
| In the 34th week, | 31 " |
| " 35th " | 31.8 " |
| " 36th " | 32 " |
| " 37th " | 32.8 " |
| " 38th " | 33.1 " |
| From the 39th to the 40th week, | 33.7 " |

But the altitude of the fundus and the maximum abdominal circumference are subject to wide variations, dependent upon the condition of the bladder and rectum, the posture of the woman, the engagement of the presenting part, the quantity of the liquor amnii, the thickness of the abdominal parietes, and the like.

5. *The Length and Weight of the Fœtus.*—The determination of the length and weight of the fœtus constitutes one of the best methods in the diagnosis of the time of pregnancy. The individual variations in length and weight at the same period of gestation are relatively unimportant. Of the tables with reference to length and weight compiled by C. Braun, Hecker, Spiegelberg, and Ahlfeld, the first is probably the most reliable.

C. BRAUN:

| | | |
|---|---|---|
| 5th month, | 26 cm. | .5 kilogr. |
| 6th " | 31 " | 1.60 " |
| 7th " | 37 " | 1.6 " |
| 8th " | 42 " | 2.2 " |
| 9th " | 47 " | 2.8 " |
| 10th " | 52 " | 3.3 " |

HECKER:

| | |
|---|---|
| 35–38 cm. | 1170 gr. |
| 39–41 " | 1571 " |
| 42–44 " | 1942 " |
| 45–47 " | 2323 " |

SPIEGELBERG:

| | | |
|---|---|---|
| 7th month, | 34.8 cm. | 1069 gr. |
| 8th " | 38.8 " | 1511 " |
| 9th " | 45.7 " | 2189 " |
| 10th " | . . . . . . . . . | |

AHLFELD:

| | |
|---|---|
| 38.3 cm. | 1388 gr. |
| 42.2 " | 1880 " |
| 46.9 " | 2517 " |
| 49.8 " | 3096 " |

An approximate estimate of the length and weight of the fœtus can readily be made, upon bimanual exploration, by the expert in abdominal palpation. Indeed, Carl Braun[1] regards this as the best mode of determining the time of pregnancy, errors greater than fourteen days being very infrequent in the Vienna clinic, where this plan is almost exclusively relied upon.

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[1] *Loc. cit.*, p. 120.

Ahlfeld[1] has attempted to determine the length of the so-called fœtal axis by placing one extremity of Baudelocque's callipers upon the cephalic and the other upon the pelvic pole of the fœtal ovoid. The total length of the fœtal body is about twice this distance. In transverse presentations this datum is arrived at by abdominal measurements; in longitudinal presentations it is necessary to introduce one branch within the vagina. Given the total length, the time of gestation is calculated from the tables just mentioned. This method in Ahlfeld's hands has yielded excellent results. Zweifel,[2] Breisky, and others, however, have been less successful in its application. The method is obviously subject to essential sources of error, and it is highly probable that Braun's off-hand rule, practised by an expert in abdominal palpation, affords information just as nearly approaching correctness.

The behavior of the vaginal portion with reference to shortening and softening, to which Tarnier and French observers generally attach so much importance, is of considerable value, especially in primiparæ.

The phenomenon of lightening before labor frequently is of great service in the prediction of the day of confinement, although never of decisive value.

## THE DIAGNOSIS OF MULTIPLE PREGNANCY.

The only form of multiple pregnancy capable of positive diagnosis is that of twins. Among the probable signs worthy of special mention are the enlargement of the abdomen—greater than in correspondence with the time of gestation—with the tendency to the preponderance of the transverse over the vertical diameters; the appearance of a longitudinal furrow; the sensation of unusually active fœtal movements in all regions of the uterus; the elevation of the lower uterine segment and the absence of a presenting part; the exaggeration of all the pressure disorders of gestation, in particular the varices and œdema of the vulva and lower extremities. Of all of these symptoms, the most important is the unusual size and shape of the abdominal enlargement. The longitudinal furrow is commonly absent in multiple pregnancy, while it is frequently present in simple gestation, usually indicating the embryonal origin of the uterus out of the two halves.

The positive diagnosis depends upon signs elicited by abdominal palpation, auscultation, mensuration, and the vaginal touch.

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[1] *Arch. f. Gyn.*, Bd. ii. p. 354: "Berichte u. Arbeiten aus der Klinik zu Giessen."

[2] *Ibid.*, Bd. xxii. Heft 3, p. 491.

Budin[1] has called attention to the relative positions of the ova. Three chief types are observed. The fœtuses lie laterally, one on each side of the uterus, or one lies above, the other below, or one in front of the other. One egg may retain its nearly round outline, while the other is drawn out so as to cause its more or less complete envelopment. Under favorable conditions palpation reveals the exact presentations of the two children, or more than two large portions of the fœtal body, or a large number of upper and lower extremities. Two large portions of the fœtal body may be detected by abdominal palpation, while a third is felt *per vaginam* engaged within the pelvic inlet. One fœtus may be recognized by palpation as presenting in the first position of the vertex, while heart-tones may be heard above the umbilicus to the right of the median line.

By auscultation alone it is frequently possible to detect two areas, diametrically opposite, over which two sets of fœtal heart-tones are heard with maximum intensity. If the frequency of the heart-beats over these two areas is different, and if the transmitted maternal heart-tones can be excluded, the diagnosis is established.

In exceptional cases the vaginal touch may detect rapidly-successive presentations of the cephalic and pelvic poles of the fœtal ovoid. Depaul in two cases detected a furrow dividing the bag of waters into two parts, indicating the presence of at least two amnions.

Ahlfeld in particular has demonstrated the value of menstruation in the diagnosis of twin pregnancy. If the distance between the large part presenting and the large part at the highest point in the fundus uteri—that is, the length of the fœtal axis—is greater than 30 cm., the presumption is that the two parts belong to different fœtuses.

## THE DIAGNOSIS OF PRIMIPARITY AND MULTIPARITY.

The questions as to whether a woman has ever been pregnant, whether she is pregnant for the first time, or has already borne children, are of great medico-legal consequence. In the majority of cases pregnancy and labor leave indelible traces in the changes of the vaginal portion, vagina, hymen, vulvar orifice, the relaxed abdominal walls, the lineæ albicantes, and in the alterations of the mammæ, so that a positive diagnosis is possible.[2] Under certain conditions, however, the woman may have repeatedly borne children without the persistence of any objective changes upon which even a probable diagnosis can be established. The vaginal portion may, after the lapse of years, undergo such a degree of involution that it closely simulates the virgin organ. On the other hand, the cervix of the virgin may become the seat of morbid processes and present many of the appearances of the organ in the multipara. The objective changes measurably characteristic respectively of primiparity and multiparity have already been incidentally mentioned, and are fully considered in other sections of this work.

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[1] *Loc. cit.*, chs. xxx.-xxxv.

[2] Carl Braun: *loc. cit.*, p. 125.

## THE DIAGNOSIS OF THE LIFE OR DEATH OF THE FŒTUS.

In the perfectly healthy pregnant woman, in the absence of any special ground for a supposition to the contrary, the presumption is that the child is alive. The perception of the fœtal heart-tones, active fœtal movements, and, to a certain degree, the elasticity of the fœtal body upon palpation, render the diagnosis positive.

On the other hand, the death of the fœtus during pregnancy can only be diagnosticated with a greater or less degree of probability. The complete disappearance, sudden or gradual, of the fœtal heart-tones, the cessation of active fœtal movements, the loss of elasticity by the fœtal body, the persistence of the fœtal extremities in the positions in which they have been artificially placed, are signs presumptive of death. The fact that the mother no longer perceives fœtal movements is almost devoid of diagnostic import, since whenever uterine contractions occur the mother commonly ceases to feel such movements. Nor is the sensation of quickening diagnostic of the life of the child, for reasons already mentioned. The progressive loss in maternal weight, especially during the last three months, in the absence of any other adequate cause has been shown by Gassner to be a symptom of great value. The existence of maternal diseases—*e. g.* syphilis, which often causes fœtal death—the cessation of growth or shrinkage in the volume of the uterus and of the breasts, the maternal sensations of weight in the lower abdomen, chilliness, languor, loss of appetite, yield evidence only of a probable nature.

Schroeder[1] has shown that the fœtus is a source of heat to the uterus, and on this account the uterine temperature is normally higher than that of the vagina. This difference ceases when the fœtus dies. Cohnstein[2] and Fehling[3] have proposed to utilize this fact in the diagnosis of the life and death of the fœtus. They found in a limited number of cases that when the vaginal and uterine temperatures were the same, the fœtus was dead.

The evidence collected from all these sources is very seldom sufficient to warrant the artificial evacuation of the contents of the uterine cavity under the sole indication of the death and retention of the fœtus within the cavum uteri. In exceptional cases the finger introduced through the patulous cervical canal may detect changes in the consistence of the fœtal head and the loosening of the articulations of the cranial bones which, in connection with the signs already mentioned, justify the induction of premature labor.

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[1] *Virchow's Archiv*, Bd. xxxv.

[2] *Arch. f. Gyn.*, Bd. iv. p. 547; *Virchow's Arch.*, Bd. lxii. p. 141.

[3] *Arch. f. Gyn.*, Bd. vii. p. 143.

## The Hygiene of Pregnancy.

While pregnancy is an essentially physiological condition, still the alterations in structure and function are so numerous and so profound that attention merely to the laws of general hygiene governing conduct in the non-gravid state is entirely insufficient. It is necessary that the pregnant woman shall regulate her daily life in strict accordance with the great change in most of her relationships. The observance, however, of the dictates of a rational hygiene peculiar to the state of pregnancy does not ordinarily involve a radical change in all of the woman's former habits, so long as they are not inimical to her new condition. The hygiene of pregnancy may be briefly discussed under the following topics: food and drink, clothing, bathing, air, exercise, sleep, rest, mental condition, care of the breasts, examination of the urine, the presentation and position of the fœtus, and the pelvis.

*Food and Drink.*—The dietary should consist of a good, generous supply of proteids, fats, amyloids, salts—fresh meats, vegetables, fruit—and water. Normally, the appetite is increased after the cessation of morning sickness, the woman consuming food for two. The evening meal should always be light, and highly-spiced articles of food ought to be avoided. Within physiological limits the whims and caprices of the appetite may be humored. Milk, coffee, tea, light wines, and beer are consumed according to the woman's previous habits. It is well to exercise caution in the use of alcoholic liquors, on account of the extreme ease with which the alcoholic habit is acquired during gestation by women of all classes.

Meigs was very successful in the palliative treatment of the nausea and morning sickness of pregnancy by having his patients take a light breakfast early in the morning an hour or two before rising. A cup of coffee with a bit of toast was brought to the bedside at the earliest morning hour. The patient, suddenly awakened, took this breakfast without rising, and then fell asleep again.

Daily evacuations of the intestinal tract are secured by voluntary efforts at defecation at a fixed hour, without respect to desire, and occasional enemata of cold water. The diet, selected with reference to this end, consists largely of oatmeal porridge, brown bread, peeled ripe fruits, and the vegetable oils. Constipation is to be especially avoided during the last three months.

*Clothing.*—The clothing should be such as to protect the person from cold and at the same time not to interfere with the development of the uterus and breasts nor to compress the vessels of the lower extremities. Parvin[1] points out that the word *enceinte* means, in Latin, ungirdled or without a girdle, in commemoration "of the custom of Roman women, who, when they became pregnant, laid aside their girdle, the *fascia mammillaris*." Corsets are now obtainable specially adapted to pregnancy, so as not to compress the nipples nor interfere with the growth of the uterus and mammary glands. The clothing should be suspended, as far as possible, from the shoulders, and circular garters ought not to be worn. Pregnant women ought always to wear drawers in summer as well as in winter. Stockings must be warm, and the shoes large and with broad, low heels. In multiparæ with relaxed abdominal walls a neatly-fitting binder affords comfort and preserves the normal forward inclination of the womb.

*Bathing.*—The functional activity of the skin must be carefully maintained throughout pregnancy, and the most effective method to secure this end is the habit of frequent bathing—that is to say, daily or two or three times in the week, according to the custom of the individual—in water neither hot nor cold. Bathing in hot or cold water and sea-bathing ought to be forbidden, on account of the excitation of the vascular and nervous systems. The daily vaginal douche with tepid water is destitute of harm, while sitz-baths and foot-baths must be proscribed.

*Air, Exercise, Sleep, Rest.*—Up to the third month and during the last weeks of gestation the pregnant woman is usually indisposed to physical exertion—in the one case by morning sickness, and in the other by the increased difficulty in locomotion. In the interval, however, exercise in the open air, such as walking, to the point of slight fatigue, is of great benefit to the physical well-being of herself and the fœtus. Dancing, riding, swimming, driving over rough roads, lifting heavy weights, and the like are obviously dangerous experiments. Railway travel in comfortable cars, through limited distances, can ordinarily be permitted from the third to the eighth month; travel by water must be absolutely interdicted, the especial danger arising from sea-sickness.

The pregnant woman requires more sleep than is strictly necessary in the non-gravid state: from nine to ten hours may be accepted as an average period.

With respect to sexual intercourse during gestation, it is necessary t give advice with an extreme degree of circumspection. The physicia counsel is not often requested, and when gratuitously offered it is st more seldom acted upon.[2] During the first three months and the lat weeks of gestation it is wiser for husband and wife to occupy differe beds, as the danger of abortion or premature labor is considerable. any case in which the tendency to abortion is at all evident sexual inte course must be forbidden throughout pregnancy. During the interv between the end of the third month and the latter weeks of pregnancy, in perfectly healthy women, contact ought to depend upon the desire of the female, which, as a matter of fact, it commonly does. Roederer speaks of the *viri fastidium*, Stoltz of the *horreur du mari*, sometimes evinced by the pregnant woman. On the other hand, the weight of opinion is very much in favor of the view that in the majority of healthy pregnant women desire is greatly increased, even to the point of nymphomania. A reversal of the so-called classical posture may be suggested with perfect sobriety.

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[1] *Loc. cit.*, 211.

[2] Spiegelberg remarks, "It is preaching in the wilderness."

*Mental Condition.*—In view of the increased emotional susceptibility and frequent tendency to despondency, the mental condition of the pregnant woman demands a certain degree of attention. Presence at church, the theatre, or other places where large numbers of people are congregated is unwise, on account of the mental impression, if for no other reason. It is the physician's privilege to dispel many of the popular illusions which needlessly harass the pregnant woman by counsel and the recommendation of suitable reading. Fright, bodily violence, and the like may produce structural alterations in the egg, as the effect of hemorrhage, partial rupture of the membranes, partial loss of their contents, resulting sometimes in the production of monstrosities; but the direct influence of the mother on the moral and intellectual development of the fœtus in utero, in the absence of any such coarse physical cause, is a matter of the purest speculation.

*Care of the Breasts.*—The mammary glands must be freed from all compression and warmly covered. The nipples require more particular attention. They must be kept perfectly clean by daily washings with simple water; occasionally soap may be employed. It is a good plan during the last six weeks of gestation to bathe the nipple daily with cologne-water, tincture of benzoin, tincture of arnica, or alcohol and water. The epithelium covering the organ is stimulated and rendered less sensitive, but it is not converted into leather, as when tannin is employed. All pressure must be removed; to effect this it is seldom necessary to use nipple-shields. All manipulations of the nipple to aid in its elongation are not only useless, but positively harmful, on account of the danger of provoking uterine contractions. Recent researches into the etiology of puerperal mastitis indicate that the large proportion of mammary abscesses during the puerperium are due to the septic infection of some crack or fissure in the nipple. The prophylaxis should begin during pregnancy. Absorbent cotton or disinfected linen or gauze only should come into direct contact with the nipple.

*The Examination of the Urine.*—It is the duty of the physician to test the urine for albumen, especially during the last three months of pregnancy, at such periodic intervals as the conditions of the concrete case may determine.

*Examination of the Presentation and Position of the Fœtus and the Pelvis.*—It is also the duty of the medical attendant to determine the presentation and position of the fœtus during the latter weeks of gestation—during the thirty-second week in primiparæ, during the thirty-sixth week in multiparæ. The importance of this examination is obvious. If an abnormal presentation is present, it is usually possible to effect its transformation into a normal presentation before the advent of labor. Abdominal palpation is amply sufficient to reveal the facts desired.

It is not always necessary, nor is it always expedient, to insist upon an elaborate investigation of the dimensions of the pelvis. In the United States there exists the very decided presumption that the native-born woman has a normal pelvis. If, however, for any reason, there is cause to believe that some pelvic deformity exists, it becomes necessary to make a thorough examination at this time with reference to the possible induction of premature labor. In multiparæ the history of former labors will usually disclose the presence or absence of pelvic deformity; in primiparæ the engagement of the presenting part is presumptive of a normal pelvis.

## PATHOLOGY OF PREGNANCY.

The pregnant woman is liable to many disorders which can be directly traced to her new condition. These disorders are, for the most part, pathological exaggerations of physiological processes. Then pregnancy confers upon the individual no immunity from the diseases to which the non-pregnant woman is liable. But certain acute and chronic diseases sustaining the relation of accidental complications are variously modified as to their clinical course by pregnancy, and in turn variously influence the nature of gestation. Accordingly, the general disorders of pregnancy affecting the maternal organism may be divided into two classes: I. The Pathological Exaggerations of Physiological Processes; and II. The Peculiarities of Certain Accidental Acute and Chronic Diseases occurring in the Course of Pregnancy.

### I. THE PATHOLOGICAL EXAGGERATIONS OF PHYSIOLOGICAL PROCESSES.

It is always difficult and frequently impossible to draw the boundary-line at which normal functional activity becomes morbid. As remarked by Spiegelberg, all the diagnostic penetration of the physician is demanded to recognize this transition. Then, a high exercise of judgment is necessary to determine when to preserve a wise and masterly inactivity, when to adopt measures of active interference.

### Alterations in the Constitution of the Blood.

*Chlorosis and Hydræmia.*—The red corpuscles, albumen, and iron of the blood are normally diminished, especially during the second half of pregnancy, while the white corpuscles and fibrin receive an increment. When the number of red corpuscles is morbidly diminished, the woman becomes chlorotic. In this condition the diminution is less in the number than in the amount of hæmoglobin contained in the individual corpuscle. The color-value of each globule is lessened, and hence the peculiar yellow-green complexion from which the condition derives its name. If in addition to these changes the amount of albumen undergoes pathological diminution, hydræmia ensues. Chlorosis and hydræmia can only be regarded as independent affections in the absence of cardiac and renal lesions. Commonly, individual predisposition to impoverishment of the blood exists in marked cases. Insufficient food and bad hygienic surroundings suffice to develop this latent tendency.

Effusions into the subcutaneous connective tissue, the thoracic and abdominal cavities, are liable to occur. Sudden exudations into the pleuræ and pericardium are especially dangerous, since they often take place without sufficient symptoms to attract the woman's attention to her serious condition. The œdema of the vulva, lower abdomen, and lower extremities, sometimes actually impeding locomotion, is an annoying complication.

The relation of chlorosis and hydræmia to hydrorrhœa gravidarum and hydramnion is fully discussed in another article. It may be said, however, in passing, that the causative nature of this relation is fully established in certain cases.

Chlorosis and hydræmia have an important influence in the causation of abortion and premature labor through immediate action upon the fœtus or indirectly through the predisposition to morbid conditions of the decidua or fœtal envelopes. The various forms of simple anæmia are also of considerable prognostic moment when parturition is attended by any unusual loss of blood. In cases of the so-called habit of abortion these conditions rank only second to syphilis in the list of causative agencies.

Œdema of the face and upper extremities is rare. The urine is increased as to its water, and occasionally contains traces of albumen in the absence of kidney disease.

Treatment.—The indications for treatment are the improvement of the quality of the blood, the elimination of the superfluous water, and the alleviation of the local œdema. Nutritious food, and iron in combination with non-irritant diuretics, fulfil the first two indications. Blaud's pill (Pulv. ferri sulphat. exsiccat., Potass. carb. puræ, āā ℥ij; Syrupi q. s., ut ft. mas. div. in pil. No. xlviij) and Basham's mixture—Mistura ferri et ammonii acetatis, U. S.—are eligible preparations.

*Progressive Pernicious Anæmia.*—Gusserow[1] in 1871 clearly described a peculiar form of progressive pernicious anæmia incident to pregnancy, although Lebert mentions fatal cases of the chlorosis of pregnancy as early as 1853. The disease is of rare occurrence; Gusserow observed 5 cases in an interval of two years (1868–70) in Zürich, while Batut (1879)[2] was only able to collect 10 authentic cases; Graefe (1880),[3] 25.

ETIOLOGY.—Gusserow's cases occurred in comparatively young women, twenty-four to thirty-six years old, four being multiparæ. All were in apparently perfect health before pregnancy. A high degree of anæmia developed chiefly during the second half of gestation without evident cause, resulting in the expulsion of the fœtus about the eighth month and in death soon afterward. Endemic influences, insufficient food, hemorrhages, and all the usual causes of anæmia were carefully excluded. The rapid progress of the disease with the advance of pregnancy also favors the assumption that this form of anæmia is a pathological exaggeration of the serous plethora incident to gestation. It is altogether probable that pregnancies succeeding each other at brief intervals exercise a predisposing influence: in 4 of the cases cited 6 children were born in nine years, 7 in twelve years, and 9 in ten years.

MORBID ANATOMY.—Post-mortem examination reveals the alterations due to anæmia, hydræmia, and their sequelæ—anæmia of the brain and its membranes, effusions into the various serous cavities of the body, occasional fatty degeneration of the myocardium and blood-vessel walls, and retinal hemorrhages. The number of white blood-corpuscles is not abnormally increased, and all signs of leukæmia—splenic tumor, swelling of the lymphatic glands, and changes in the other organs of the blood-glandular system—are entirely wanting. The condition is that of oligæmia or oligocythosis.

SYMPTOMS.—The prodromal symptoms appear during the first half of pregnancy, are obscure, and cannot be distinguished from the effects of chlorosis and hydræmia. During the second half of pregnancy abortion or premature labor occurs spontaneously. The fœtus is commonly stillborn or dies within a few hours of birth. The muscular exertion and loss of blood consequent upon parturition usually precipitate the lethal issue in the case of the mother.

PROGNOSIS.—All of the 5 cases reported by Gusserow terminated fatally. Out of the 25 cases collected by Graefe, 1 recovered, 2 were discharged as improved, the others died before or shortly after labor.

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[1] *Arch. f. Gyn.*, Bd. ii. p. 218.

[2] *Thèse de Paris.*

[3] *Diss. In., Halle.*

TREATMENT.—As food, iron, and other tonics have little or no effect upon the disease after it has passed its incipient stages, therapeutic resources are limited. Negative results have followed all attempts at transfusion. This operation, however, has been commonly performed very late in the course of the disease. With more perfect methods and greater experience transfusion at an early period is certainly worthy of more extended trial.

Gusserow, Gfoerer, and others recommend the artificial induction of abortion or premature labor. In the three cases recorded by Graefe in which the patients survived pregnancy the evacuation of the uterine contents apparently exercised a favorable influence upon the condition of the blood. To be of decisive value, the cavity of the uterus must be evacuated early in the course of the disease, as, when once fully established, the prognosis is quite as unfavorable in the non-gravid as in the pregnant woman (Biermer, Immermann).

*Hæmophilia.*—Kehrer[1] clearly describes three cases of hæmophilia occurring during pregnancy which are of peculiar interest, inasmuch as they throw some light on the pathology of this obscure disorder. The salient features of these cases are, very briefly—

CASE I.—Fr. H——ch, from Giessen, twenty-eight years old, small, slender, fresh-appearing laborer's wife. Epistaxis during youth. First pregnancy and labor normal. During second pregnancy severe uterine hemorrhages and nose-bleedings, once hæmatemesis. Induction of abortion at the end of the eighth week on account of the increasing anæmia. After both abortions speedy cessation of the hemorrhages. During the succeeding two years no repetition of the hemorrhages, and the patient was apparently in a normal condition.

CASE II.—Frau M——s, large, well-formed, pallid woman, twenty-three years old. Three abortions, with profuse hemorrhage, within the first three years of her marriage. During the fourth pregnancy frequent severe nose-bleedings; in the fourth month continuous hæmaturia, then epistaxis. Premature labor at the beginning of the eighth month. Death from anæmia one month later.

CASE III.—Fr. F——k, from Giessen, large, slender, well-nourished, pale blond, twenty-seven years old. Epistaxis during youth, profuse menstruation. In the second half of the third pregnancy profuse nose-bleeding until term. During the puerperium either nose-bleeding or metrorrhagia; numerous sudden gushes of blood from the uterus. Death, two months after labor, from anæmia.

ETIOLOGY.—In these, as in the majority of cases recorded, the disposition to hemorrhage was hereditary. The diathesis is transmitted through the male line. Atavism by transmission is commonly observed in the female. The daughters of a "bleeder," while remaining apparently healthy themselves, are apt to transmit the disposition to their male offspring, and the diathesis may extend through four or five generations. The old observation, that "bleeder" families are remarkably fertile, has been abundantly confirmed. Pregnancy exerts decided influence in the development of hæmophilia. In all the cases related by Kehrer there was a longer or shorter interval of complete freedom from bleeding before conception. During the continuance of gestation the disposition to hemorrhage increased constantly and rapidly. With the cessation of pregnancy in Case I. the tendency again sank into abeyance. The disease assumes a severer type in the multipara than in the primipara. In Case I. the first pregnancy and labor were perfectly normal. In Cases II. and III. the diathesis, leading to death, was developed respectively during the fourth and third pregnancies.

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[1] "Die Hæmophilie beim weiblichen Geschlechte," *Arch. f. Gyn.*, Bd. x. p. 201.

PATHOLOGY.—Two factors are usually present in hæmophilia in the male and the non-gravid female—congenital fragility of the vessels and defective coagulability of the blood.[1] But in Kehrer's cases, especially in Nos. I. and II., the blood from the nose and the uterus coagulated in a perfectly normal manner, and no important quantitative or qualitative changes were observed. In favor of the view that in these cases, at least, the hæmophilia was due to structural changes in the blood-vessel walls, the following facts may be mentioned: the great disproportion between the cause and the effect, the long duration of the hemorrhage in spite of the employment of styptics and other measures, and the changeable locality of the bleeding. Changes in the joints, so frequently observed in male bleeders, were notably absent.

DIAGNOSIS.—Pernicious anæmia, leukæmia, and scorbutus can usually be excluded by the absence of their measurably characteristic symptoms. The fact of heredity, the history of epistaxis, hæmatemesis, purpura, vicarious and other menstrual anomalies during youth, and the general behavior of the bleedings, render the recognition of the disorder comparatively easy.

PROGNOSIS.—The outlook with reference to the mother and child is obviously very serious, and its gravity increases with the duration of pregnancy.

TREATMENT.—Women of the hemorrhagic diathesis ought not to marry nor bear children. If they themselves are not bleeders, the usually transmit the disposition to their male offspring. The same rule ought to govern the conduct of male bleeders.

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[1] Klebs and certain other pathologists assert that the changes in the constitution the blood in hæmophilia are relatively insignificant, but that the essential morbid condition is structural changes in the blood-vessel walls. Klebs defines hæmophilia as parablastic, hereditary disturbance, in which only one portion of the connective-tis blastema is affected—namely, the blood-vessel system (*Allgemeine Pathologie, etc.*, Je 1887, Theil i. p. 28).

Pregnant women, the subjects of hæmophilia, seldom die during the first bleeding, so that there is commonly ample time to carefully weigh all the facts in the concrete case before resorting to radical measures of treatment. The diet should be bland and non-irritant, inasmuch as a relatively insignificant elevation of blood-pressure may cause the renewal of the bleeding. Indeed, all the hygienic conditions of the case must be regulated with this fact clearly in view. The local arrest of hemorrhage is best effected by graduated mechanical pressure, styptics being f only palliative value. In metrorrhagia the vaginal tamponade is he only reliable measure. Iron and the long list of remedies of such ndoubted worth in simple anæmia and allied disorders are absolutely alueless in the condition under consideration.

The objective point of all the preparatory treatment here indicated is he artificial evacuation of the uterine contents—abortion or premature abor—at the earliest moment the conditions of the concrete case will ermit. This operation, to offer a reasonable prospect of recovery, ust be performed before a serious degree of anæmia has resulted from he bleeding. Otherwise, it merely precipitates the lethal issue. All recautions must be taken to prevent post-partum hemorrhage—a frequent and usually a fatal sequela.

*Plethora.*—The experiments of Spiegelberg and Gscheidlen, already entioned, prove the possibility of the occurrence of so-called arterial lethora during pregnancy, notwithstanding the fact that in recent athology general and persistent polyæmia plays a very subordinate ôle. Actual increase in the red corpuscles, albumen, iron, and total lood-mass is sometimes observed during the second half of pregnancy nder the most favorable conditions respecting the individual and the nvironment. Still less frequently does this state of the blood give rigin to unpleasant symptoms. Occasionally, however, cases are bserved in which various local congestions are best explained upon this hypothesis. The symptoms are—congestions of the head and ammæ, palpitations, tendency to vertigo, disturbances of the portal irculation, and hepatic torpor, constipation.

The indications for TREATMENT are met by restricted diet, muscular xercise, and an occasional saline purge. Spiegelberg recommends leeding in selected cases, as frequently practised by country practitioners.

## CIRCULATORY DISTURBANCES.

*Œdema and Varices.*—Among the circulatory disturbances incident o pregnancy, the mechanical œdema and varices of the vulva, rectum, nd lower extremities deserve attention.

Varices occur in pregnancy in the proportion of 20–30 per centum, according to Budin;[1] in 21 per centum, according to Cazin.[2] They are more distinct, but not more frequent, in multiparæ than in primiparæ.

The qualitative and quantitative changes in the blood and individual differences in the tonus of the blood-vessel walls are the important predisposing factors. Early in pregnancy, before considerable enlargement of the uterus, these phenomena are caused by a slowing of the blood-current in the veins of the lower extremities, resulting from the dilatation of the pelvic veins. Later, the constantly-increasing intra-abdominal pressure, corresponding with the augmentation of uterine volume to which the inferior vena cava is exposed throughout nearly its entire course, is the important determining agent. During the last weeks the head and lower uterine segment, engaged within the pelvic cavity, directly compress the iliac veins.

As the force and frequency of the intermittent uterine contractions increase, a new etiological factor makes its appearance. During the systole of the uterus the blood is squeezed out of the uterine walls and the maternal placenta into the extra-uterine blood-vessels. The longer the duration and the greater the force of each contraction, the profounder is the degree of anæmia. During the beginning of the systole the quantity of blood in the extra-uterine venous channels is increased, while the advent of arterial blood is retarded.[3] At the acme, even a backward current in the arteries is produced when the intra-uterine pressure is greater than the pressure in the maternal sinuses.

Posture exercises a decided influence. Women who preserve the erect attitude and work during pregnancy are much more subject to œdema and varices than those who spend the greater portion of the period in the recumbent position.

The mechanical œdema of pregnancy is restricted to the subcutaneous connective tissue of the lower abdomen, the vulva, and the lower extremities, becoming most pronounced during the latter months, but never attaining the proportions of the anasarca of hydræmia or of Bright's disease. During the night, while the patient is lying in the horizontal position, it commonly disappears.

Active measures for the relief of the symptoms are seldom indicated. Threatened gangrene of the skin from hyperdistension, however, may render puncture of the hydropsical regions necessary. It is quite possible to interrupt pregnancy by this little operation, especially if the labia are punctured. Elevation of the lower extremities, rest in the dorsal decubitus, local hot-water packs, mild diuretics, elastic bandages and stockings, commonly fulfil all indications for treatment.

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[1] "Des Varices chez la Femme enceinte," *Thèse d'Agrégation*, Paris, 1880.

[2] *Archives de Tocologie*, 1880-81.

[3] Lahs: *Loc. cit.*, p. 87.

Varices of the vulva seldom give origin to serious symptoms during pregnancy, but are of considerable clinical significance during labor. Spiegelberg[1] records one death from hemorrhage in a VI.-para in the ninth month, the bleeding occurring from a varix in the right labium. The rupture is seldom spontaneous—commonly the result of trauma, as the patient's scratching to relieve the itching to which a varicose part is subject. The formation of thrombi, inflammation, suppuration, and the process of embolism are possible, though rare, complications.

Hemorrhoids, of relatively frequent occurrence during pregnancy, are observed more often during the puerperium. As a rule, varices of the anus and lower portion of the rectum in the pregnant woman are due to constipation and the straining efforts during the act of defecation. Probably in the majority of cases the condition is in existence prior to pregnancy. Direct interference with the return of the venous blood from the inferior portion of the rectum by the uterus is observed only during the first trimester and after the engagement within the pelvic cavity of the head and lower uterine segment. Although causing unpleasant symptoms during pregnancy, their chief clinical significance commences with labor and the puerperium. Occasionally, hemorrhoids during gestation are the site of alarming hemorrhage and the point of departure of anal fissures and fistulæ (Verneuil).

The superficial varices of the lower extremities are only the consequences and manifestations of the same condition in the deep-lying veins. Frequently they are capillary, and form blue networks around the malleoli and to the inner surfaces of the thighs. The internal and external saphenous veins are commonly involved. Large congeries of dilated veins are found over the inner sides of the thighs, usually above the knees. Fatal hemorrhage during pregnancy is a rare phenomenon. Spiegelberg, however, records three cases of this character: Case No. I., VII.-para, in the eighth month, femoral varix; Case No. II., I.-para, in the twenty-fourth week, varix on the posterior aspect of the upper third of the right thigh; Case No. III., I.-para, in the twenty-fourth week, near term, varix on the inner surface of the left thigh in the vicinity of the knee. Phlebitis and the processes of thrombosis and embolism are of obvious significance even when the loss of blood is trivial. The rupture of the vein under these conditions is usually the result of trauma, although Bryant[2] records a case of spontaneous laceration of the internal saphena, with the formation of a thrombus on the inner surface of the thigh.

TREATMENT.—The preventive treatment of the hemorrhoids of pregnancy, labor, and the puerperium consists largely in the treatment of constipation, securing regular and gentle evacuation of the bowels.

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[1] *Loc. cit.*, p. 235.

[2] *Med. Times and Gazette*, 1850.

Fordyce Barker[1] has called attention to the great value of aloes in the treatment of piles occurring during pregnancy. He states that Oppolzer was especially renowned for his skill in the treatment of this condition. For piles associated with constipation he used aloes and quinine; without constipation, aloes and sulphate of iron. For bleeding hemorrhoids he suggested the following formula: ℞. Ferri sulphatis, gr. xx; Ext. aloës aq., ʒj; Ext. taraxaci, q. s. Ft. pil. No. 60. S.—One pill morning and evening, and increase to three a day if necessary. Large purgative doses of aloes, however, must be avoided during pregnancy, on account of the marked influence of the drug upon the pelvic circulation. Frequent hot fomentations in connection with anodyne and astringent ointments will relieve the pain from congestion of the hemorrhoids. Iodoform, applied in solution or in substance as a suppository, is an efficient local anæsthetic. It is even asserted that this drug "will so benumb the parts that defecation may take place without the person or animal being aware of it."[2] All operative interference for the purpose of effecting a radical cure is strongly contraindicated, on account of the extreme danger of interrupting pregnancy. Even attempts at reduction must be instituted with extreme care.

Elevation of the lower extremities and equable compression by an elastic bandage or rubber stocking palliate the symptoms caused by varices of the lower extremities. P. Ruge,[3] A. Martin, Vogt, and others have observed favorable results in severe cases from the hypodermic injection of ergotin; Englisch, from the injection of equal parts of alcohol and water. The injection is made into the connective tissue beneath the varix. It is seldom necessary, however, to resort to such radical measures, as the condition usually disappears during the puerperium.

In the event of rupture of a varix the wound is treated in accordance with the well-known principles of antiseptic surgery.

*Simple Goitre.*—The physiological hypertrophy of the thyroid gland at puberty and during pregnancy has been already mentioned. The exaggeration of this normal enlargement to such a degree as to be productive of serious symptoms is not an infrequent disorder of pregnancy.

ETIOLOGY.—The causation of the bronchocele occurring in pregnancy is very obscure. The hereditary character of goitre in these cases has been frequently asserted, although never clearly established. The disease is certainly not endemic.

A number of facts, fully supported by abundant clinical observation, render the theory almost certain that some necessary relation exists between pregnancy and certain cases of simple goitre. The disease is very much more common in women than in men.[1] The intimate relation between menstruation and menstrual disorders and the thyroid is fully established.[2] The same connection between this gland and functional and organic disorders of the uterus and ovaries has been observed. The disease is observed much more frequently in women who have borne children than in sterile married women.[3] Bronchocele often makes its first appearance during pregnancy, increases rapidly in size during this period, and subsequently becomes reduced in volume. These facts indicate that whatever the true causes of simple goitre may be, pregnancy is often the actual exciting and determining cause.

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[1] *American Practitioner*, 1872.

[2] H. C. Wood: *Therapeutics, etc.*, 6th ed., 1887, p. 446.

[3] *Berl. Beitr. z. Geb. u. Gyn.*, Bd. iii. p. 7.

PATHOLOGY.—The pathology of simple goitre in pregnancy is largely a matter of speculation. Poincaré[4] points out the great richness of the gland in nervous filaments of all sizes, out of proportion to the number of blood-vessels, and is of the opinion that the close relationship between the thyroid and the generative organs is of a sensory nature. Sloan believes the pregnant womb exerts a determining influence in the development of bronchocele "through the sympathetic nervous system, from the inferior and middle cervical ganglion of which its main nerve-supply is derived." Laycock[5] asserts that in "90 per centum of ordinary cases it is the ovaria which have this influence."

The condition has been ascribed to the increased force of the heart's action during pregnancy—an untenable hypothesis. Kocher's experiments seem to indicate that the thyroid may secrete a substance necessary to the nutriment of the brain, and that its size in pregnancy is due to increased functional activity. Finally, it is alleged that the thyroid, as a member of the blood-glandular system, is actively involved in the blood-changes incident to pregnancy.

MORBID ANATOMY.—Wölfler has carefully examined the numerous thyroids extirpated by Billroth, many of which were directly traceable to pregnancy. He found that apart from the tumors of struma cystica, the large proportion of specimens were examples of pure adenomata or cysto-adenomata. The tissue showed widely different degrees of consistence—sometimes foci of secondary metamorphoses. Cystic degeneration, blood-extravasations the result of amyloid degeneration of the blood-vessel walls, fatty degeneration and caseation with the deposition of crystals of cholesterin, and calcification, are among the more important secondary changes.

Sometimes the goitre becomes the seat of active inflammation with abscess formation, as in the cases described by Dolbeau and Charpentier.

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[1] Laycock: in 26 men out of 551 cases.

[2] Lawson Tait: *Obstet. Journ.*, 1875; E. W. Jenks: "The Relations of Goitre to Pregnancy and Derangements of the Generative Organs of Women," *Am. Journ. of Obstet.*, 1881.

[3] Allen Thompson Sloan: *Edin. Med. Journ.*, September, 1886, p. 207.

[4] Robin's *Journal de l'Anatomie*.

[5] *Lecture on the Goitrous Diathesis.*

CLINICAL COURSE.—The thyroid gland, first becoming prominent at puberty, remains stationary until pregnancy supervenes. During the first or second pregnancy the gland increases rapidly in size, but seldom giving rise to symptoms of severe dyspnœa. In the interval between labor and the succeeding pregnancy the tumor is reduced in size, but remains a little larger than it was before pregnancy. With the succeeding gestation it grows more rapidly, frequently attaining enormous proportions, threatening death from asphyxia, only to be reduced again in volume after labor. This process continues with each successive pregnancy, provided the woman does not succumb to the mechanical interference with respiration, until the menopause, when the tumor diminishes greatly in size or in rare cases entirely disappears.

The enlargement begins in one lobe, and subsequently becomes symmetrical. When one lobe only is involved, the trachea is frequently dislodged from its normal relations. A great increase in the size of the tumor is not always essential to the production of dangerous asphyxia. When the tumor develops behind the trachea or in the substernal region, a relatively slight increase in volume is sufficient to seriously compress the windpipe.

Sudden death from asphyxia may result, as pointed out by Rose, from the softening of the tracheal cartilages and pressure-atrophy effected by the presence of the tumor. Under these conditions the trachea is reduced to a membranous tube, and the sudden turning of the head to one side is sometimes sufficient to occlude its lumen. Béclard and J. Colquet have recorded cases in which sudden asphyxia was developed during labor as the result of rupture of the blood-vessels within the parenchyma of the organ.

Charles Caldwell[2] has recently reported a case of goitre complicating pregnancy, which also came under the writer's observation: Fr. G——, born in Königsberg in 1852, vigorous, healthy woman, of medium stature and great muscular development. No history of goitre in her family, and the disease not endemic in the region of her birth. Patient was married in 1872, and has borne ten children. No enlargement of the thyroid was noticed before marriage nor during her first four pregnancies, the terminations of which were perfectly normal. These children were born in Germany, the others, six, in the United States during the last nine years. During the fifth pregnancy the left lobe of the thyroid began to grow larger, but did not occasion any distress. The lobe gained permanently in size during the sixth and seventh pregnancies, but was productive of neither pain nor dyspnœa; normal deliveries. During the eighth pregnancy the right lobe began to grow larger and the isthmus became very perceptible. Pain and dyspnœa became

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[1] Billroth: *Die Allgemeine Chirurgische Pathologie, etc.*, 1882, p. 870.

[2] *Journ. Am. Med. Ass.*, Oct. 8, 1887, p. 472.

very marked, and were rapidly aggravated with the progress of gestation. During the latter half of this pregnancy the patient was compelled to assume a semi-recumbent position at night. During the last three months she was obliged to sit up at night supported by pillows. This posture, which she was often compelled to assume during the day, exerted a pressure upon the fundus uteri sufficient to cause an elongation of the transverse and a shortening of the vertical diameters, resulting in a total transformation of the form of the uterus into that of a transverse oval.

June 1, 1884, Dr. Caldwell was summoned to attend the woman in her confinement. He found her threatened with asphyxia and the fœtus presenting transversely. Podalic version by Braxton Hicks' method was performed, and the child safely delivered. On the fourth day afterward, contrary to instructions, the woman resumed her customary household duties.

October 16, 1885, Dr. Caldwell was again called to attend the woman in confinement. During this her ninth pregnancy, the tumor had grown much larger, and the pain and dyspnœa had increased proportionately. The woman was not so profoundly asphyxiated as in her eighth labor, since she had summoned the physician earlier. The fœtus was found presenting transversely, with the right arm and pulseless cord protruding through the vulvar orifice. The dead child, weighing nearly twenty pounds, was successfully delivered by podalic version, and the patient left her bed, as before, on the fourth day of the puerperium.

February 18, 1887, Dr. Caldwell saw the woman in her tenth confinement. The tumor had increased in size, measuring eighteen inches transversely over the isthmus; augmented pain and dyspnœa. Transverse presentation; delivery of a living child, weighing twelve pounds, by podalic version. Puerperium as before.

Nov. 26, 1887, *status præsens.* The tumor has diminished one-fourth in size, and the woman suffers no pain nor dyspnœa. Her health in other respects is perfect. Careful examination of the heart reveals no enlargement. The children showed no congenital enlargement of the thyroid, and no symptoms have appeared as yet to indicate the transmission of the so-called goitrous diathesis. This remarkable case presents the following points of interest:

I. The apparent absence of any hereditary or endemic influence or strumous diathesis in the development of the goitre. The disease seems to have been clearly due to pregnancy.

II. Alarming asphyxia usually began about the seventh month of pregnancy.

III. The posture of the woman undoubtedly exercised an important influence in the alteration of the form of the uterus and in the determination of transverse presentations.

Roberts[1] has reported three cases of goitre occurring in primiparæ. The tumors were apparently incident to pregnancy, and all three cases terminated fatally by asphyxia.

In forming a prognosis and in the institution of treatment the fact must be borne in mind that apart from the immediate danger of asphyxia the hyperplastic changes of goitre may be the point of departure of carcinoma.

TREATMENT.—It is questionable whether women of the so-called goitrous diathesis or those in whom the thyroid is already considerably enlarged should become pregnant.

Medicines, exhibited per os or applied locally, are of very limited value after the swelling has attained considerable proportions. In the early stages iodine, applied locally, is entitled to a trial. The local application of the biniodide of mercury is a favorite method of treatment in the tropics.[2] In the East Indies and in South America it is customary to rub an ointment (three drachms biniodide of mercury to one pound of lard) into the skin over the tumor in the morning. A fresh portion is then applied and left to undergo resorption, while the tumor is exposed to the rays of the sun. Macleod has seen much good result from this mode of treatment in Scotland, where fire-heat was substituted for the sun's rays.

Lücke and Schwalbe recommend parenchymatous injections of tincture of iodine. Ergotin, alcohol, iodoform (℞. Iodoformi, Glycerin., Aquæ destill., *āā.* partes æqual. Mucil. gummi arabici q. s., ut fiat emulsio), carbolic acid (5 per cent. solution), are also used for the purpose of parenchymatous injection. It is scarcely necessary to state that the skin, needle, and the drug employed must be absolutely free from all pathogenic micro-organisms; otherwise there is grave danger of inflammation and septicæmia, as in the case cited by Billroth.[3]

The various preparations of iodoform exhibited per os are very much less efficient than when applied locally.

In the event of threatened asphyxia, two operations come up for consideration—tracheotomy and the induction of abortion, or more commonly the induction of premature labor. The indications for each operation are usually perfectly clear. When asphyxia is imminent, tracheotomy is indicated; when the element of time is not so important, the artificial evacuation of the uterine contents.

In recent years the technique of total extirpation of the enlarged thyroid gland has reached such a high degree of perfection, and the mortality of the operation has been reduced to such a small figure, chiefly as the result of Billroth's labors, that the procedure merits consideration. The state of pregnancy, *per se*, is not a contraindication.

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[1] *Am. Journ. Med. Sci.*, October, 1876.

[2] Monat: *Indian Annals of Medical Sciences*, 1857.

[3] *Loc. cit.*, p. 873.

It must be remembered, however, that in this operation, even to a greater degree than in Cæsarean section, the experience and skill of the operator determine the force of the indication and the conduct in the concrete case.

## DISORDERS OF THE ALIMENTARY CANAL.

*The Pernicious Vomiting of Pregnancy.*—Nausea, even vomiting, in the morning, before or shortly after meals, during the early months of gestation is so common and devoid of injurious effect that it is regarded as physiological. The incoercible, pernicious vomiting of pregnancy, in which the stomach retains absolutely nothing, is a very grave disorder. The beginning of the affection is gradual. A slight increase in the familiar morning sickness is observed, and the patient vomits at various periods through the day. She complains of loss of appetite and disgust for certain articles of food for which she formerly evinced desire. The secretions of the salivary glands are increased. Changes in the mental condition are apparent, and the woman becomes irritable, despondent, or apathetic. Horwitz[1] observed in two cases the periodical occurrence of increased sensitiveness of the sense of smell. These perceptions are often purely subjective, but they are nevertheless sufficient to increase the nausea, just as in hyperosmia from other causes.

Nausea becomes more intense, while pyrosis and hiccough are constant and distressing symptoms. The intervals between the attacks grow shorter, until the vomiting, accompanied by violent retching, becomes almost continuous. The stomach finally becomes so irritable that neither food nor drink is retained, and even the very thought of either provokes an attack. The patient throws up glairy mucus, clear or colored with bile. Ultimately, the vomit is mixed with blood. The woman is worn out and restless from loss of sleep and the painful efforts at vomiting. Very soon she begins to lose in weight, and symptoms closely resembling those of acute starvation appear. The buccal cavity is dry, the tongue red and shining, the teeth and gums covered with sordes, the breath horribly fetid, the skin dry and harsh. Extreme thirst is constant; salivation is frequently observed. In exceptional cases the loss in weight is insignificant, and the woman may perish without any sensible alteration in the subcutaneous adipose tissue.[2] Diarrhœa is observed more frequently than constipation, although there is no uniformity with reference to the changes in the functions of the intestinal tract.

Fever of a continued type, with a quick, rapid, thready pulse, is commonly developed. This symptom is not constant, as numerous observers—Zweifel, Rosenthal, Horwitz—have failed to detect any considerable elevation of temperature. Dubois[1] and observers of the American, French, and English schools, however, have accumulated clinical observations sufficient to establish the fact of its occurrence in the majority of cases. Icterus occasionally appears in the course of the fever.

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[1] *Zeitschr. f. Geb. u. Gyn.*, Bd. ix. p. 110.

[2] Rosenthal: *Berl. klin. Wochenschr.*, 1879, No. 26.

The causation of this febrile condition is unknown. Septicæmia from intra-uterine changes cannot be invoked, since the fœtus is usually alive when the fever first develops. Robert Barnes refers it to an alleged blood-poisoning from "the rapid disintegration of all the tissues, most marked in the fat-tissue."

The belly becomes tender on pressure and tympanites is developed. The urine is sparingly secreted, concentrated, and contains albumen and tube-casts. In general, the changes in this secretion are analogous to those found in acute starvation. According to Voit, the excretion of urea is usually, but not invariably, diminished.

During the last stage of the disease the vomiting abates or ceases entirely, while the fever increases and the pulse grows small and frequent. Syncope is frequent; hallucinations and delirium supervene, and the patient dies in coma or is carried off suddenly by some intercurrent malady.

Between the slight nausea upon rising in the morning and the state of extreme marasmus thus briefly sketched every degree of pathological variation may be observed.

It is a remarkable fact that the incessant vomiting, retching, and hiccough seldom interrupt pregnancy until shortly before the termination of the disease, when the loss of blood and muscular exertion consequent upon the expulsion of the product of conception from the uterus may precipitate the lethal issue. Occasionally, spontaneous abortion occurs early in the course of the disorder before the patient's condition is desperate. Then the vomiting commonly ceases at once.

In cases of gloomiest prognosis the same sudden cessation of the vomiting is sometimes seen without any apparent cause for the change. This alteration for the better is often observed after quickening, rapid eccentric hypertrophy of the uterus, and after the death of the fœtus.

The course of the disorder is chronic. Cases terminate in recovery or death in from six weeks to three months. Alarming symptom are commonly developed between the second and fourth months; very seldom between the fourth and sixth months; still less frequently at a later period.

Fortunately, the pernicious vomiting of pregnancy is a rare affection. So few cases are recorded in German medical literature that H oh denied the existence of the affection. Carl Braun,[1] in a fabulous experience of over one hundred and fifty thousand obstetrical cases, has never observed a single fatal termination. On the other hand, Robert Barnes[2] has himself seen 9 fatal cases. McClintock[3] remarks: "With a very moderate amount of research I have been able to collect close on fifty authentically-recorded cases, and I know of others which have not been published." O. W. Doe[4] has collected 48 cases of this disorder, with 18 deaths, all occurring within the last ten or fifteen years and registered in American and English journals. Guéniot[5] records 118 cases, with 46 deaths. This diversity in the observation of accomplished obstetricians is suggestive. It seems hardly probable that national characteristics, the environment, or other conditions are adequate to the creation of such essential changes in the course of this disorder. It is a noteworthy fact that in many of the cases of death from alleged hyperemesis of pregnancy the diagnosis was not verified by post-mortem examination.

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[1] "Leçon de M. P. Dubois, par M. Laloris," *Union médical*, 1848 and 1852.

[2] Kleinwächter: *Grundriss d. Geburtshülfe*, 1881, p. 197; *Lehrb. der Geb.*, 2te Au 1862, p. 728.

The affection is of more frequent occurrence among primigravidæ than among multigravidæ. Rosenthal,[6] indeed, has collected 100 cases, of which 67 were multiparæ and 33 primiparæ; but, as pointed out by Horwitz, these cases cannot all be referred to the category of the hyperemesis of pregnancy.

Etiology.—The oldest and most generally accepted view of the pathogenesis of this disorder is that it is a reflex phenomenon. As the essential predisposing causes it is necessary to bear in mind the changes in the constitution of the blood and the alterations in the functions of the nervous system incident to pregnancy. The germinal mass within the uterus gives origin to numerous peripheral irritants. There is nothing strange nor out of the usual course of nature in this manifestation. Reflex nausea, or even vomiting, is by no means an uncommon symptom in various morbid states of the womb in the non-gravid woman. Thus, this symptom is sometimes observed in chronic metritis and pathological conditions of the vaginal portion. Tilt records a case of fatal hyperemesis alleged to have been caused by a uterine fibroid. Opinions, however, differ widely as to the exact nature of the peripheral irritant.

Bretonneau insisted upon the importance, as an etiological factor, of the stretching of the uterine fibres by the growing ovum, and the consequent compression or irritation of the nerves distributed to this viscus. There are many facts in support of this theory of passive uterine distension. Hyperemesis is of more frequent occurrence and of a severer type, as a rule, in the primigravida than in the multigravida. It is commonly observed during the first half of pregnancy. It is of frequent occurrence in cases of passive distension of the uterus, as in multiple pregnancy, hydramnion, and hydatidiform mole. Immediate cessation of all symptoms is commonly noted after quickening, rapid growth of the uterus, death of the fœtus, and evacuation of the uterine contents; that is, when the factor of mechanical distension is eliminated.

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[1] *Loc. cit.*, p. 842.

[2] *Loc. cit.*, p. 274.

[3] *Dubl. Journ. Med. Sci.*, 1873.

[4] *Boston Med. and Surg. Journ.*, Feb. 11, 1886.

[5] *Thèse Agrégation*, 1863.

[6] *Loc. cit.*

Graily Hewitt[1] has attached great significance to flexions and versions of the uterus as causes of the affection under consideration. The nerves from the cervical ganglion are pinched at the angle of flexure or are compressed by the inflammatory changes incident to the alterations in the form or position of the womb. He explains the morning attacks and the aggravation of the vomiting when the patient is erect by asserting that the flexion or displacement is at the same time increased by the superincumbent intestinal mass. This hypothesis offers an entirely inadequate explanation, since the uterus has been found to be of normal form and position in many of the recorded cases of hyperemesis, and in very many cases of anteflexion and retroflexion with corresponding displacements the vomiting has been notably absent. It is not at all improbable, however, that in a limited number of cases this factor plays an important rôle.

J. H. Bennet,[2] in particular, has directed attention to pathological conditions of the vaginal portion—inflammatory states, and especially erosions and excoriations of the os externum—in their causal relation to this disorder. It is altogether probable that the operation of this cause is more extensive than clinical observers have been disposed to admit. A case in point has recently come under the writer's observation. A vigorous young woman passed through her first pregnancy without the common morning sickness. During parturition an extensive bilateral laceration of the vaginal portion occurred. The puerperium was perfectly normal and involution of the genital tract apparently complete. Two years later she became pregnant for the second time, when she began to complain of morning sickness, rapidly developing into pernicious vomiting. It was possible to exclude inflammations of the uterine musculature, peritoneum, and mucous membrane, and attention to the local condition of the vaginal portion apparently relieved the hyperemesis. Numerous similar cases are on record.

The anatomical relations of the vaginal portion to the cervical ganglion, and the favorable influence of certain therapeutic measures addressed to this organ, lend great probability to Bennet's theory. Nevertheless, it cannot be accepted as a universal explanation, since erosions, and even extensive lacerations, are often present in the entire absence of the disorder, and, on the other hand, hyperemesis sometimes occurs when the vaginal portion is in a perfectly normal state, so far as may be ascertained by the means at disposal.

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[1] *Transactions of the Obstetrical Society of London*, 1872, p. 103.

[2] "On Obstinate Sickness during Pregnancy," *Brit. Med. Journ.*, June 12, 1875.

Horwitz and others are inclined to assign to parenchymatous inflammation of the uterine parietes the chief rôle in the causation of the majority of cases of hyperemesis. Pregnancy occurs in a uterus already the site of chronic metritis. The uterus is of larger size than in correspondence with the epoch of gestation, and it is also abnormally sensitive, with diminished mobility. Horwitz also emphasizes the causal importance of inflammations of the pelvic connective tissue and peritoneum—a view to which Joulin[1] has previously given expression.

A more important etiological factor than chronic metritis, but one to which this condition undoubtedly predisposes, consists in endometritis gravidarum—a morbid state to which Ebell and J. Veit[2] in particular have directed attention in recent years. Pregnancy almost invariably exerts an unfavorable influence on chronic endometritis; under the stimulus of the increased nutritive energy of the mucosa incident to pregnancy formative changes rapidly occur which not infrequently lead to abortion or premature labor. Veit records three cases in which these changes stood in causal nexus with hyperemesis, the diagnosis being confirmed by the macroscopical and microscopical characters of the decidua serotina and vera.

Probably in the very large majority of cases the excentric irritant consists in some morbid change in the form or position of the uterus, the condition of the vaginal portion, the uterine parenchyma, the pelvic peritoneum and connective tissue, the endometrium, either alone or in combination. In a certain class of cases, however, the pathogenesis of the disorder is to be found in the exaggeration of some morbid condition of the gastric or intestinal mucous membrane, which prior to gestation was not sufficient to seriously attract the patient's attention, but which under the influence of pregnancy develops into hyperemesis. No causal relation has been demonstrated between pregnancy and simple gastric ulcer, but, given the latter condition, the morning sickness of pregnancy aids in the development of a formidable disease. The changes in the blood, and consequent local disturbances in the circulation of the gastric mucosa, leading to the formation of ulcer (Rokitansky, Virchow), cannot be invoked, since, as before remarked, these changes are chiefly pronounced during the second half of pregnancy. Horwitz records a case of fatal hyperemesis of pregnancy in which chronic catarrhal gastritis had existed for some time prior to conception. The slight tendency to nausea and vomiting at once became exaggerated, and the patient died of exhaustion, notwithstanding the artificial induction of abortion. The autopsy revealed phlegmonous inflammation of the stomach with important diminution of its lumen. In another case terminating fatally from exhaustion and septic toxæmia, notwithstanding the spontaneous occurrence of premature labor, the same observer noted polypoid new formations of the mucous membrane of the colon as the cause of vomiting. The neoplasmata were located in the colon long before conception, but under the influence of gestation they had apparently grown so rapidly that the reflex irritation was sufficient to provoke fatal hyperemesis. Horwitz[1] has formulated the facts just indicated in the following proposition: "The greater the disposition of any section of the alimentary canal to a morbid state, the greater the ease with which the vomiting of pregnancy becomes uncontrollable."

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[1] *Traité complet d'Avortement.* Paris, 1867.

[2] *Berl. klin. Wochenschr.*, 1887, No. 35, p. 643.

The mechanism of the reflex vomiting of pregnancy has been the subject of recent investigation. Tumas,[2] from experiments on cats and dogs, localizes with tolerable precision the situation and extent of the vomiting centre. He asserts that it lies in a small space before and behind the calamus and in the deeper layers of the medulla, near to or in close communication with the centre which, by inference, presides over the organs of generation.[3] The two distinct qualifications common to all organisms are—(1) self-maintenance, and (2) the perpetuation of the species. A close relationship therefore throughout life exists between the processes of assimilation and reproduction, and it is probable that their representative nerve-centres act and react upon each other. "When the uterus becomes the nidus for a developing germinal mass, the molecular disturbances radiated therefrom to the reproductive centre are liable to be transmitted to the pneumogastric as well, and induce either a feeling of nausea or actual emesis. Usually, however, in the course of a few months, through habit, the pneumogastric centre becomes tolerant, and the symptom evidencing disturbance at the same time disappears." But the nervous system of the pregnant woman is uncommonly susceptible to molecular radiations, and the latter are liable to augmentations and modifications from pathological conditions in connection with the womb, so that the normal morning sickness is developed into pernicious vomiting. Oliver suggests, in explanation of the fact that the nausea and vomiting of pregnancy occur in the morning, that the change "from the recumbent to the erect position after sleep renders the whole nervous system more liable to explosive disturbances." Epileptics often experience seizures only upon rising after sleep.

Lebert and Rosenthal are of the opinion that certain cases of hyperemesis are referable to a general inanition of the nervous tissue in connection with, or in the absence of, peripheral irritants in the uterus or morbid states of the alimentary canal. Kiwisch found a sufficient cause in the relation between the hyperæsthetic gastric nerves and the hydræmic condition of the blood during pregnancy. Frerichs has pointed out the connection of hyperemesis with the renal inadequacy of Bright's disease. Such cases, however, are plainly not due immediately to pregnancy, and cannot be discussed under the topic now being considered.

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[1] *Loc. cit.*, p. 161.

[2] *Lancet*, Oct. 1, 1887.

[3] James Oliver: "The Cause of the Morning Sickness during Pregnancy," *Brit. Med. Journ.*, Oct. 1, 1887, p. 717.

Race, social condition, and temperament would seem, from the widely-different views upon the frequency of the occurrence of this disorder, to exercise an almost determining influence. As before remarked, comparatively few severe cases are recorded in German medical literature. Ahlfeld[1] has only observed three cases in which he seriously considered the artificial interruption of pregnancy. In each of these cases it was possible to alleviate the disorder without recourse to the evacuation of the uterine contents. Winckel and Cohnstein have been equally successful in the treatment of this disorder and by similar therapeutic means. On the other hand, P. Dubois[2] asserts that he himself observed twenty fatal cases. Mention has already been made of the alleged comparative frequency of the disorder in America and England. The nature of this influence, if its existence be admitted, is purely conjectural.

This brief sketch of the causation of the pernicious vomiting of pregnancy does not exhaust the numerous ingenious theories and hypotheses, more or less adequately explanatory of certain cases, with which the literature of the subject abounds. Notwithstanding the extent and, in general, the accuracy of etiological research into the nature of the disorder, a class of cases still remains in which no organic change capable of objective demonstration can be found. This class of cases, however, is constantly diminishing in number.

DIAGNOSIS.—The diagnosis of the pernicious vomiting of pregnancy is not so easy as at first seems apparent. It is not at all improbable that the difference of opinion as to the frequency of this disorder between the Germans upon the one hand and the American, French, and English observers upon the other, depends in a large measure upon the difference in diagnostic criteria insisted upon by the respective schools. In the majority of the fatal cases of alleged hyperemesis due to pregnancy reported by American, French, and English observers there is, as before remarked, a notable absence of reliable records of post-mortem examinations. In the few cases collected by the Germans, on the other hand, the diagnosis *in viva* has almost invariably been confirmed or negatived by exact investigation of the dead body.

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[1] *Arch. f. Gyn.*, Bd. xviii. p. 310.

[2] *Loc. cit.*

Horocks[1] pertinently remarks: "Where there has been no post-mortem examination in a fatal case of vomiting, I do not think one is entitled to say that the pregnancy caused the fatal vomiting. It may have been the cause, and the only cause, or it may have been an aggravation of some other cause, or it may have had nothing to do with it." Scepticism as to the alleged frequency of this disorder in the present state of our knowledge is accordingly eminently in order.

Until the major premise as to diagnosis is adequately determined, it is not only useless, but deplorably unwise, to speculate as to the possible influence of race, temperament, environment, and the like. Incidentally, it may be remarked that the influence of such conditions upon this aspect of pregnancy is absolutely hypothetical. There are no facts in our possession which would indicate a lesser degree of nervous susceptibility in the Teutonic pregnant female than in her American, French, English, or Russian sister.

Guéniot[2] calls attention to three distinct elements in the diagnosis of the pernicious vomiting of pregnancy:

I. The diagnosis of pregnancy. This element in the diagnosis usually involves no especial difficulty when the pregnancy is advanced to the twelfth week, but before this period it is only in exceptional cases that a positive judgment can be formed.[3]

II. The diagnosis of the adjuvant or determining cause of the vomiting. In the large majority of cases the adjuvant or determining cause consists in some morbid change in the uterus which is not always capable of objective demonstration. In chronic interstitial decidual endometritis the diagnosis is commonly made only after expulsion of the ovum and the examination of the fœtal envelopes. In hydrorrhœa gravidarum, however, the symptoms are often sufficient to establish the diagnosis. When the vomiting is due to the aggravation of some previously-existing condition, as chronic gastritis and gastric ulcer, the history of the case yields important data. It is perhaps needless to remark that success in treatment depends in a large measure upon the adequacy of the recognition of this element in the diagnosis.

III. The differential diagnosis between the obstinate vomiting due to pregnancy and the obstinate vomiting due to other causes entirely independent of gestation. The most eminent clinicians have committed grievous errors in diagnosis, especially in this element. Thus, Trousseau[4] once made the diagnosis of uncontrollable vomiting and induced abortion in a case in which the autopsy revealed cancer of the stomach. Beau[1] made the same mistake in diagnosis in a case in which the post-mortem examination showed tuberculous meningitis as the probable cause of the vomiting. Horocks[2] has recently described a case of severe vomiting in pregnancy terminating in death after miscarriage. The necropsy revealed the liver extensively diseased by a primary encephaloid carcinoma, the parts not infiltrated by cancer being fatty. In commenting upon this case Horocks remarks: "It may be that the cancer of the liver had nothing to do with the severe vomiting in this case; but had there been no pregnancy I do not think any one would have thought there was anything strange in this symptom with such a lesion, whilst the vomiting itself was so severe as to be, at all events, very unusual from pregnancy alone."

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[1] *Brit. Med. Journ.*, 1886.

[2] *Loc. cit.*

[3] Thus, Cazeaux narrates the history of a fatal case of alleged hyperemesis of pregnancy in which the autopsy disclosed tubercular peritonitis and the absence of pregnancy.

[4] Depaul.

Prognosis.—Severe vomiting in pregnancy is always ground for anxiety, and the prognosis must always be guarded. When the symptom is due to pregnancy alone, in the entire absence of the aggravation of any previously existing condition, the outlook is favorable. It is doubtful whether an authentic fatal case of this kind is recorded. Such cases have never been seen by observers of the largest experience.

When the vomiting is due to the aggravation of a previously-existing lesion of the alimentary canal, the prognosis becomes more serious. Particularly is this statement true of gastric ulcer. Perforation not infrequently follows the violent efforts at retching and vomiting. Mention has already been made of the phlegmonous inflammation of the gastric parietes as a sequela of antecedent chronic catarrhal gastritis.

Cases of gloomiest prognosis are those in which the hyperemesis sustains no causal relation to pregnancy.

The prognosis with reference to the child, so far as it is influenced directly by the defective nutrition of the mother, is not unfavorable. Death of the fœtus from inanition and spontaneous abortion or premature labor, as before remarked, is a very exceptional occurrence.

Treatment.—The treatment of the pernicious vomiting of pregnancy depends largely upon the accurate recognition of the adjuvant and determining causes. An efficient rational therapeusis must consist in the elimination or modification of these etiological factors as far as the conditions of the concrete case will permit. The treatment naturally resolves itself into—(1) hygienic; (2) medical; (3) gynecological; (4) obstetrical.

*Hygienic.*—The hygienic treatment is of avail in the minor degrees of the disorder, although not without definite influence in the more serious cases. Diet is of primary importance. Let the patient breakfast upon a morsel of toast or cracker with a small cupful of strong coffee or tea, half a cupful of milk and lime-water, early in the morning, in bed in the horizontal position, and lie quietly for one or two hours after the meal. Small quantities of easily-digestible food—peptonized milk, egg-albumen in water, animal broths—at brief intervals will be tolerated when the patient has given up all pretence at keeping to regular meals. Koumiss, milk and soda-water, dry champagne, are frequently grateful beverages on account of the carbonic acid. Absolute dietetic rules, however, cannot be maintained. The stomach of the pregnant woman is proverbially capricious and fanciful. Charpentier narrates the history of a case suggestive in connection with this subject. The patient, four months advanced in pregnancy, in a critical condition from uncontrollable vomiting, came under the care of Beau in the Hôpital de la Charité. One day she asked for crawfish *à la bordelaise*. Beau granted her request, and at once ordered the crawfish from a neighboring café. On the first day two crawfish were retained; on the second, six; on the third, crawfish *ad libitum*, bouillon, and milk. "How often, indeed," remarks Cazeaux, "have I not seen women eat ham, pâté-de-foie-gras, and the like, who could not digest a piece of sole or the white meat of fowl!" It is necessary to respect these caprices and fancies.

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[1] Charpentier.

[2] *Loc. cit.*

When all food exhibited per os is rejected, absolute stomach-rest is indicated. Nutrient enemata may now be tried. Of the great value of rectal alimentation under these conditions there can be no doubt. Henry F. Campbell[1] relates the history of a case of pernicious vomiting of pregnancy in which he fed the patient by the rectum alone for fifty-two days. In commenting upon the value of this method Campbell remarks: "Under the careful and systematic application of rectal alimentation artificial abortion for the relief of gravid nausea can be banished from practice, even as a last resort." There is some danger, however, of irritating the mucosa of the intestine and causing diarrhœa—a peculiarly unfavorable complication at this time. This danger can be obviated commonly by attention to the quantity of fluid injected, the number of the enemata, and the chemical reaction of the foods. Of the various nutrient enemata, Leube's beef-and-pancreas mixture,[2] cream, defibrinated beef's blood,[3] peptonized milk, egg-albumen, beef-extracts containing soluble albuminoids, are among the best. From four to six ounces should be exhibited, not more frequently than once in six hours. The chemical reaction of the fluid employed should be of such a degree of alkalinity as to correspond with that of the succus entericus.

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[1] *Trans. Am. Gyn. Soc.*, vol. iii.

[2] Foster: *Clinical Medicine*, p. 24. The formula for Leube's beef-and-pancreas mixture is five to ten ounces of finely-chopped beef; one-third as much finely-minced pancreas (pig or ox). Treat this mixture in a mortar with five fluidounces of lukewarm water.

[3] The late Albert H. Smith suggests the addition of one grain and a half of chloral to the fluidounce to prevent decomposition.

Alexander Harkin[1] asserts that there is a hyperæsthetic spot over the fourth or fifth dorsal vertebra, or over both, as the normal condition of every person. By blistering these spots this observer claims to have cured certain cases of hyperemesis of pregnancy. The experience of Prince[2] has in part confirmed Harkin's observations. There is some evidence that hyperæsthetic areas exist in the œsophagus, and Bruenniche[3] has successfully treated the uncontrollable vomiting of pregnancy by the introduction of a tube part-way through the gullet, but not into the stomach. In one case milk, broths, and pulverized beef were thus introduced and retained within the stomach. As soon as the patient attempted to swallow, however, the vomiting recurred. Kohler, Maere,[4] and De la Roche have successfully treated obstinate hysterical vomiting by spraying the pharynx with the muriate of cocaine, with and without the subsequent use of the œsophageal tube.

In the severer cases the patient should be confined to her bed in the horizontal position, the room darkened, and the highest possible degree of mental and physical rest maintained. The beneficial effect of rest in the horizontal position on sea-sickness is well known, and its influence is only slightly less marked in the disorder under discussion. Sexual intercourse must be forbidden.

Weir Mitchell's[5] methods of renewing the vitality of feeble people by entire rest, and feeding in connection with passive exercise, are of value in certain cases.

The obstinate constipation frequently observed in this condition demands attention before recourse to active therapeusis.

*Medical.*—There are few drugs in the Pharmacopœia which have not been vaunted as specifics by some and found utterly worthless by others. This fact justifies the belief, as remarked by Schroeder, that all remedies are unreliable, and that spontaneous cures frequently occur.

In the minor degrees of the disorder remedies which exert a local influence upon the mucous membrane of the stomach are of decided value. Subnitrate of bismuth, oxalate of cerium (Sir James Y. Simpson), soda mint (℞. Sodii bicarb., gr. iv; Ammon. carb., gr. $\frac{1}{4}$; Ol. menthæ pip., gr. $\frac{1}{8}$), magnesia usta, correct excessive acidity and are mechanical sedatives. Small doses of the tincture of nux vomica are useful in chronic catarrhal gastritis. The various local anæsthetics are of importance. Cocaine has been extolled by Weiss, Otto,[6] Manasseien,[6] and others. This drug may be exhibited in small doses—one-eighth to one-quarter grain—at short intervals until the physiological action is evident. Otto has used cocaine with benefit in the aggravated cases of sea-sickness of pregnant women. Aconite diminishes the sensibility of the afferent peripheral nerves or benumbs the sensory reflex centres. Belladonna, creasote, carbolic acid, and the volatile oils may also be included in this list of more or less efficient remedies. One drop of the wine of ipecacuanha in a teaspoonful of water, given every hour, occasionally yields excellent results.

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[1] *The Lancet*, 1884.

[2] *Bost. Med. and Surg. Journ.*, Ap. 15, 1886.

[3] *Hospital-Tidende*, 1885, No. 29.

[4] *The Lancet*, 1886.

[5] *Fat and Blood*, Philadelphia, 1885.

[6] *Berl. klin. Woch.*, 1815, Nos. 35 and 43.

Talma[1] ascribes the disorder to cerebral anæmia, and advises the use of nitro-glycerin, the drug being exhibited in alcoholic solution or in olive oil in capsules. One milligramme is administered daily in three doses.

Alcohol is of undoubted value in cases of centric emesis. It is quite possible that the great value of champagne in sea-sickness and in certain cases of the vomiting of pregnancy is due not so much to its local action as to its absorption.

Of all medical agents, however, chloral, the bromides, and the preparations of opium are by far the most reliable, especially when the diagnosis of the purely reflex nature of the vomiting is reasonably clear. Under these conditions it is well to resort at once to these drugs, without temporizing with the remedies already mentioned. Chloral and the bromides are best exhibited by the rectum. Doses of sufficient size, and repeated at such intervals as to depress—and maintain in this state—reflex activity, are indicated. Thirty grains of chloral and sixty of potassium bromide may be added to one of the nutrient enemata, and the dose repeated, according to the indications in the concrete case, from one to three times in the course of twenty-four hours. Hypodermatic injections of morphine and atropine or suppositories of the aqueous extract of opium will frequently allay the distressing symptom after the failure of other measures. In many cases the exhibition of opium is contraindicated by the very great secondary nausea, depression, or even excitement, which it causes. Potassium bromide, as pointed out by Da Costa, and atropine, measurably counteract this tendency.

Blisters, the ether spray, the Faradic current applied to the epigastrium, Chapman's ice-bag applied to the dorso-lumbar region, have been of avail in the minor degrees of hyperemesis.

*Gynecological.*—Under the gynecological treatment a number of important operative procedures are included. Commonly, a rational indication for their employment exists and can be made out; in many cases, however, their use is entirely empirical.

1. If bimanual exploration reveals any morbid uterine displacement capable of producing symptoms, an attempt at rectification must be

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[1] *Revue Medico-chirurgicale des Maladies des Femmes*, Feb., 1886.

made. However, it is necessary to bear in mind the facts that the normal position of the pregnant uterus is one of anteversion or even mobile anteflexion, and that a certain degree of retroversion and retroflexion[1] can exist without the production of symptoms. Efforts at replacement must be extremely gentle. Henry F. Campbell has repeatedly expressed his confidence in the method of postural pneumatic reduction in the genupectoral position. This mode of reduction in pregnancy, when the retroverted uterus is not fixed, with or without manipulation through the vagina or rectum, is of undoubtedly very great value, notwithstanding the strictures of Simpson and Hart to the contrary. When replacement has been effected, the organ is retained in position by the cotton-wool tampon, posture, or, in a limited number of cases, by a properly-fitting pessary. Graily Hewitt's well-known advocacy of anteversion and anteflexion pessaries in this condition has not met with general professional approval. It is not at all improbable that the alleged relief experienced after the application of these pessaries in the many cases reported by this observer was merely a coincidence.

2. Local treatment of the vaginal portion constitutes by far the most effective procedure under this heading. M. O. Jones of Chicago many years since suggested the local application of a 10 per cent. solution of argentic nitrate in cases in which some morbid state was present. General attention was attracted to this method by J. Marion Sims. At the present time the plan is employed universally, and Carl Braun regards its efficiency as considerably greater than that of any other single mode of treatment. As practised in Vienna, the woman is placed in the lithotomy position, and after a vaginal douche Braun's hard-rubber cylindrical speculum is introduced and the vaginal portion engaged within the field. A 10 per cent. solution of nitrate of silver is poured into the speculum until the vaginal portion is completely covered. The solution is allowed to remain ten to twenty minutes, when it is decanted. The indication for the use of this method has been generalized in Vienna, so that it is now employed in all cases of severe vomiting, irrespective of the condition of the vaginal portion, as a purely empirical resource. It is seldom necessary to make more than two or three applications. The weight of testimony in favor of this simple procedure collected from innumerable sources is so great as to make its employment absolutely obligatory before resort to more radical methods.

Bretonneau suggested the application of belladonna to the abdomen, in the belief that the vomiting was caused by rigidity of the uterus. Cazeaux smeared the vaginal portion and the vaginal vault with the soft extract. Success attended the efforts of both observers in some cases, while the remedy was without effect in others. Cazeaux recommends the introduction of a tampon covered with the extract of belladonna against the vaginal portion.

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[1] Braune's *Frozen Sections*, Tab. ii. B.

William Duncan[1] records three cases in which complete and rapid relief followed the local application of cocaine. A 15 per cent. solution was painted over the vaginal portion and vaginal vault, while an application was made to the cervical canal by means of a probe wrapped with cotton. The introduction of such an instrument within the cervical canal is obviously a hazardous experiment, even in the hands of an expert. Successful results with the local application of this drug have also been noted by other observers.

In the event of some morbid state of the vaginal portion apparent to the eye or examining finger, local treatment in accordance with established principles is eminently indicated.

Of the value of treatment under these conditions there can be no doubt. Jacob Price[2] commends this therapy in no equivocal terms when he says: "I know of no disease of equal gravity that so surely yields to established rules of treatment as this one does to treatment based upon the view of a congestive or inflammatory causation—viz. rest in bed, emollient, mildly-astringent vaginal injections, the tepid sitz-bath, and especially, in extreme cases, the topical application of Battey's or a similar sedative lotion to the uterine cervix. I am sure that no one who carefully and intelligently carries out this plan of treatment will fail to bring relief in the most obstinate case."

3. Copeman[3] of Norwich, desirous of inducing abortion in a case of the uncontrollable vomiting of pregnancy, pushed the index finger through the cervical canal to the membranes and attempted to puncture the amnion with a sound. Failing to accomplish his purpose, he went home for assistance, and returned at the expiration of two hours. To his surprise, the hyperemesis had suddenly ceased. Since 1875, when this observer first published the results of this experience, cases have rapidly multiplied in which this method has been successfully applied. W. Gill Wylie[4] has devised a steel dilator as a substitute for the index finger. When the os externum is at all patulous, the index finger is altogether the safest and most efficient instrument. The plan of dilatation of the os externum and cervix by the index finger is a purely empirical procedure, does not always secure the desired result, and frequently causes abortion or premature labor. Nevertheless, as the ultimate resort before the evacuation of the uterine contents it has important functions.

*Obstetrical.*—The artificial evacuation of the uterine contents, if effected before the development of the febrile stage, is commonly followed by immediate cessation of the vomiting. In the large majority of cases the disorder terminates in recovery or death prior to the period of fœtal viability, so that the indication for the induction of abortion, and not of premature labor, must be considered.

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[1] *The Lancet*, Oct. 15, 1887, p. 754.

[2] *Transactions of the Medical Society of the State of Pennsylvania*, for 1884, "Address in Obstetrics."

[3] *Brit. Med. Journ.*, 1875, 1879.

[4] *N. Y. Med. Record*, Dec. 6, 1884.

But the same end may be attained in almost every case by the judicious combination of the hygienic, medical, and gynecological methods of treatment which have just been mentioned.

When the vomiting is not due to pregnancy, of course the interruption of pregnancy can have no directly favorable influence upon the course of the disorder. The rule that no case of fatal vomiting in pregnancy can be regarded as due to pregnancy in the absence of an autopsy invalidates the statistics already mentioned, as well as those of Joulin.[1] This observer has collected 121 cases of alleged pernicious vomiting of pregnancy, of which 49, or 44 per cent., were fatal.

Observers of the largest general experience (C. Braun, Kiwisch, Hohl, Ahlfeld, Hausmann, Cohnstein, Cazeaux) have seldom or never been compelled to resort to this last expedient.

Carl Braun[2] voices a very general professional conviction upon this subject in the following words: "I myself have never observed a lethal issue in consequence of the uncontrollable vomiting of pregnancy. I lay the greatest weight upon the expectant management and more modern medicamentation, and am of the opinion that after a conscientious estimate of all considerations and contraindications, artificial abortion may be omitted, notwithstanding its permissibility from a scientific point of view when extreme danger to maternal life has been determined by several physicians."

When serious disease of the decidua exists an important objection to the induction of abortion is removed.

*Ptyalism.*—The excessive secretion of saliva in the absence of pernicious vomiting is a rare disorder of pregnancy. The symptom commonly makes its appearance early and disappears spontaneously between the third and fourth months, although in exceptional cases it persists throughout the term of gestation, and even for some weeks after labor. The disorder is probably a reflex neurosis, and frequently returns in successive pregnancies. The constant dribbling of the secretion from the buccal cavity is always annoying to the patient. When the quantity reaches several quarts per diem the patient's life may be seriously endangered from inanition. Important qualitative changes occur in the saliva. The water is largely increased, while the organic and inorganic substances are diminished. In a case observed by Schramm[3] the disturbances of nutrition were probably due to the alteration in the constitution of the saliva, which deprived it of all digestive activity, ptyalin being entirely absent. The buccal mucous membrane is red and tumid. The parotid and submaxillary glands are swollen and tender. The absence of fetor serves to distinguish the salivation incident to pregnancy from the ptyalism of mercurial poisoning.

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[1] Collected from Deblet, Fabre, Guéniot, and others.

[2] *Loc. cit.*, p. 842.

[3] *Berl. klin. Wochenschr.*, 1886, No. 49.

The disorder commonly opposes an obstinate resistance to all methods of treatment. A generous diet, the free exhibition of iron, and astringent mouth-washes mitigate in some degree the severity of the symptoms. Atropine[1] has been injected hypodermatically over the enlarged salivary glands, on account of its well-known effect on the chorda tympani, with varying degrees of success. Pilocarpine is of some value in certain cases. Iodide of potassium is in general contraindicated, on account of its effect in the causation of uterine contractions. In small doses, however, the remedy is often efficient. Bromide of potassium is, of all remedies, probably the most reliable.

*Gingivitis.*—Inflammation of the gums, commonly observed in connection with salivation, sometimes occurs in its absence. According to Pinard the disorder is commonly seen in multiparæ rather than in primiparæ. In 75 women—43 multiparæ and 32 primiparæ—this disorder was observed thirty-one times among the former and fourteen times among the latter.

The changes in the blood incident to pregnancy seem to play the chief rôle in the predisposition to this affection. The disorder is characterized by redness, swelling, and retraction of the gums, which are tender and bleed on pressure. The teeth are often loosened in their sockets and their necks exposed to the altered secretions of the buccal cavity, which are often acid. Mastication is frequently difficult and painful.

Extreme attention to the hygiene of the teeth is indicated. It is a good plan to rub precipitated chalk into the crevices between the teeth at night before going to bed, and to allow the protective to remain. Astringent alkaline dentifrices palliate the symptoms. Drugs exhibited per os, apart from the chalybeate tonics, exercise but little influence on the course of the affection, which usually persists through the term of pregnancy, and sometimes through lactation.

*Constipation.*—Constipation is a common, sometimes a troublesome, attendant upon gestation. In the majority of cases the habit is formed long before the occurrence of pregnancy. During gestation the chief etiological factors are the defective innervation of the intestines, alterations in the intestinal secretions, and the changes in the anterior abdominal wall, which interfere especially during the second half of pregnancy with its functional activity in the act of defecation. The direct mechanical pressure of the gravid uterus upon the intestinal mass is practically

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[1] Ebstein: *Berl. klin. Wochenschr.*, 1873, No. 25.

[2] Schramm: *loc. cit.*

*nil*, as demonstrated by the plane frozen sections already mentioned. Constipation is of considerable prognostic moment, since it predisposes to hemorrhoids, and during the latter months, since the colon is distended with scybalous masses, it may act as an exciting cause of abortion or premature labor. Attention has already been directed to the hygienic treatment of this state. In the selection of aperient remedies care must be taken to choose laxatives and avoid drastic cathartics. The compound licorice powder and confection of senna of the U. S. Pharmacopœia, Hunyadi, Friederichshalle, and Pullna mineral waters, may be included in the list. Thomas recommends a modified confection of senna, which yields excellent results. The formula is—figs, 1 pound; senna, 2 ounces; coriander-seed, 1 ounce; sugar, enough to make a paste.

*Diarrhœa.*—Diarrhœa is a less frequent but more serious complication of pregnancy than constipation. In the early and latter months the disorder is liable to occur from mechanical compression of the rectum by the gravid uterus. Dysentery with tormina and tenesmus is a peculiarly unfavorable complication. The dangers are apparent. Not only is the blood impoverished, but also there is grave danger of the induction of abortion or premature labor. Accordingly, every diarrhœa occurring during pregnancy demands immediate attention.

*Icterus.*—Icterus is observed with relative infrequency during pregnancy.[1] Two distinct types, simple and malignant jaundice, are capable of recognition.

*Simple Jaundice.*—Simple icterus may occur at any time during gestation. At times it runs its usual course without untoward effect upon the maternal health. In very many cases, however, pregnancy[2] is the adequate cause of the transformation of a simple catarrhal icterus into the malignant jaundice symptomatic of acute yellow atrophy of the liver. Spiegelberg[3] attributes the unfavorable influence of pregnancy upon simple icterus to the following conditions: 1. The venous congestion and other circulatory disturbances in the kidneys incident to pregnancy, which limit the compensatory excretion of the bile salts. Traube and others have shown that the retention within the blood of the bile acids is capable of causing acute yellow atrophy of the liver. 2. The alterations in the blood caused by pregnancy, which diminish the physiological resistance of this fluid itself, as well as that of all the tissues. 3. The depression of cardiac energy by the accumulation of the bile acids in the blood, which still further diminishes the excretory functions of the kidneys.

The influence of icterus upon the course of pregnancy is equally unfavorable. The fœtus commonly dies early in the course of the disorder, and abortion or premature labor results. Out of 57 cases collected by Lomer, 45 fœtuses were stillborn. In these cases simple icterus was just as fatal to the product of conception as the malignant form of the disorder. The cause of fœtal death is due in the majority of cases, as pointed out by Davidson, to the bile acids which have been found in the fœtal blood. As a rule, the skin of the fœtus is not icteroid. Out of 62 cases collected by Lomer, the fœtuses were icteroid in only 6, although the liquor amnii was stained with the biliary coloring matters in all. As pointed out by Lomer, it is highly probable that this fact is due to the difficulty in passing the placenta experienced by all slightly soluble substances.

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[1] Carl Braun observed 18 cases in 28,000 pregnant women (1857–63).

[2] Lomer: "Ueber die Bedeutung des Icterus gravidarum für Mutter und Kind," *Zeitschr. f. Geb. u. Gyn.*, Bd. xiii. p. 173.

[3] *Loc. cit.*, p. 246; Davidson: *Mon. f. Geburts.*, Bd. xxx. H. 6, p. 465.

If the icterus is intense and has persisted for a considerable period of time, the skin and all the tissues are apt to be tinged with the bile-pigments—a condition termed cirrhonosis by Lobstein.[1]

The causes of simple jaundice in pregnancy are identical with those which produce the condition in the non-gravid state, and are frequently obscure. It is in a high degree probable that pressure from the gravid uterus is entirely inoperative, since the symptom may appear at any time during gestation. The morbid condition commonly present is a catarrhal inflammation of the mucous membrane of the common bile-duct or of the duodenum in the vicinity of the orifice, causing a narrowing of its lumen.

Diagnosis.—The conjunctivæ, skin, and urine are colored bright yellow, and there is complete absence of febrile and cerebral symptoms.

Prognosis.—The prognosis with reference to the mother must always be guarded, in view of the unfavorable influence exerted by pregnancy upon the course of the disease. In the present state of our knowledge it is impossible to make even a general statement as to the relative frequency of this occurrence. The outlook with reference to the child is always gloomy. In the few cases in which a living child has been born death has commonly resulted within the first days of the puerperium.

Treatment.—Active medical treatment, in accordance with the well-known principles, is strongly indicated just as soon as the icterus make its appearance. Excretion by the kidneys must be stimulated, and rendered compensatory as nearly as possible. The induction of premature labor in the interest of the mother is seldom indicated, inasmuch as the prompt institution of a rational therapy usually removes the morbid condition. When the icterus is intense and of long duration, this operation is frequently indicated in the interest of the child.

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[1] In Carl Braun's cases, already mentioned, the condition was probably due to hypertrophic hepatitis in one case, to disturbances in connection with the ductus choledochus in seventeen cases.

The force and frequency of the fœtal heart-beats demand attentive observation, and in the event of the appearance of signs of impending death pregnancy must be prematurely interrupted.

*Malignant Jaundice.*—Acute yellow atrophy of the liver is a rare complication of pregnancy. Carl Braun[1] observed the condition only once in 28,000 pregnant women (1857–63); Spaeth[2] saw the disorder only three times in 14,061 pregnant women. The rarity of the affection renders the view improbable that pregnancy exercises a very strongly predisposing influence. A large contingent of the cases recorded, however, is afforded by pregnant women. Out of 143 cases of acute yellow atrophy of the liver in which the diagnosis was verified by autopsy, Thierfelder[3] demonstrated the coexistence of pregnancy in 30. In 69 cases recorded by Legg, pregnancy was ascertained to exist in 25.[4]

Three principal views are held with reference to the nature of this disease:

1. That it is the local expression of a general infection, especially aided in its development by the kidneys and nervous system. The agent of infection may be specific, the result of a typhous process or of puerperal sepsis.

2. That it is an essential primary disease of the liver, characterized by hyperæmia, exudation, and necrosis.

3. That it is due to the resorption of bile and to the solution of the hepatic cells by these matters retained in the blood. Thierfelder has shown that essentially different morbid states—cirrhosis, chronic fatty degeneration of the liver, compression of the bile-ducts by tumors, puerperal fever, relapsing fever, typhus, phosphorus-poisoning—having in common the single symptom of the stasis of the hepatic secretions and excretions, may under certain conditions terminate in acute yellow atrophy. Lomer suggests the plausible hypothesis that pregnancy supplies the necessary conditions for the dissolution of the blood-corpuscles and the hepatic cells by the retained bile acids.

MORBID ANATOMY.—The liver is ochre-colored, shrunken to one half its volume, and flaccid. On section no traces of its lobular structure are visible. Microscopical examination reveals total destruction of the acini and hepatic cells. In the place of the glandular elements, fat-globules, fine granular detritus, crystals of leucin and tyrosin, are noted. The spleen is enlarged and the kidneys show acute inflammatory changes. Extensive ecchymoses are observed in the meninges, under the skin, pericardium, and in the gastric mucous membrane. All the tissues are stained with bile. The blood shows profound disorganization, with the solution of the red corpuscles.

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[1] *Loc. cit.*, p. 848.

[2] *Wiener med. Wochenschr.*, 1854, p. 757.

[3] *Ziemssen's Handbuch*, 1878.

[4] Lomer: *loc. cit.*, p. 181.

SYMPTOMS.—"The prodromal symptoms," remarks Frerichs,[1] "are those of catarrhal gastro-enteritis," with the presence of a simple icterus which may last eight to fourteen days. A slight elevation of temperature may precede by several days the development of cerebral symptoms. Difficulty in speech, headache, disorders of the senses followed by delirium, convulsions—cholæmic eclampsia—and coma are the more important symptoms of cerebral origin. The pulse is remarkably small and frequent. The temperature is at first elevated several degrees, but becomes subnormal prior to death. The urine is sparingly secreted, highly colored by the bile-pigments, and contains albumen, tube-casts, leucin, and tyrosin. Urea, uric acid, and the urates are diminished. This combination of symptoms points to the retention within the blood of the waste products normally excreted by the liver and kidneys. Ultimately, a condition of complete hepatic and renal insufficiency is established.

DIAGNOSIS.—The dull yellow color of the skin, the fever, and the cerebral symptoms are signs of chief diagnostic import. Physical exploration reveals tenderness on pressure and rapidly-diminishing area of hepatic dulness on percussion. Acute phosphorus-poisoning, a toxæmia closely resembling acute yellow atrophy of the liver, must be excluded.

PROGNOSIS.—It is doubtful whether an authentic case of this disease has ever terminated in recovery. Examples of cure in supposed cases of acute yellow atrophy of the liver have been reported by Oppolzer, Lebert, and Harley. The accuracy of the diagnosis in these cases may well be questioned, since the very conception of the disease involves the idea of a fatal termination.

TREATMENT.—Therapeutic measures must be addressed to prophylaxis, since the course of the disease is rapid, commonly terminating within a few days. It is necessary to regard simple icterus as a possible prodrome of the malignant form of the disorder.

*Diabetes.*—The most superficial discussion of the disorders of pregnancy would be incomplete without brief mention of diabetes. Unfortunately, the observation of the clinical course of this affection during gestation has up to the present thrown but little light upon the pathology and treatment of the disease. Attention has already been called to the occurrence of physiological glycosuria during pregnancy, the puerperium, and lactation. Claude Bernard has shown that glucose appears in the placentæ of calves at an early period, attains its maximum in the third or fourth month, and entirely disappears when the glycogenic function of the fœtal liver is established. The relation between physiological glycosuria and that morbid exaggeration of a normal process, diabetes mellitus, is very obscure. It is, however, a clinical fact that diabetes mellitus occurs more frequently in the pregnant than in the non-gravid woman.

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[1] *Klinik der Leberkr.*, Bd. i. p. 206.

It is asserted that diabetic women are less apt to conceive. When conception does occur, pregnancy is liable to interruption from the death of the fœtus. In 7 of 19 pregnancies occurring in 14 women, collected by Matthews Duncan,[1] the fœtus died after reaching the age of viability. In 2 cases the child was feeble and died within a few hours of birth. In one case diabetes was observed in the infant. Hydramnion is of relatively frequent occurrence, and in one case the presence of glucose in the fluid was demonstrated. It is alleged that the fœtus is commonly of extraordinary size.

The influence of pregnancy in developing a latent diabetic tendency may be accepted as highly probable. Bennewitz records an interesting case in which the disorder appeared in the fourth, fifth, and sixth pregnancies, disappearing in the intervals. The fifth child was premature and stillborn.

In the fifteen women the history of whose cases is narrated by Duncan the age varied from twenty-one to thirty-eight years. With one exception they were multiparæ. Four cases terminated fatally after delivery: in one of these death occurred after the induction of premature labor. Death resulted from collapse rather than from coma.

The same observer[2] has recently reported certain cases of diabetes insipidus in pregnancy. One of them was congenital and persisted through eleven pregnancies. In another case four pregnancies occurred. Notable diminution in the amount of urea was observed.

In the fragmentary state of our knowledge with reference to the distinctive characteristics conferred upon diabetes by pregnancy it is impossible to formulate general statements as to prognosis.

There is great diversity of opinion upon the subject of the induction of premature labor. On *a-priori* grounds it would seem to be indicated in the interest both of the mother and of the child in the graver cases. In the entire absence of authoritative clinical experience, however, the operation must be resorted to with an extreme degree of caution.

## DISEASES OF THE KIDNEYS.

*Albuminuria.—Frequency.*—Albumen, according to Schroeder,[3] is found in the urine of from 3 to 5 per cent. of all pregnant women, and is of still more frequent occurrence during labor. Ingerslev[4] discovered albuminuria in 29 out of 600 pregnant women, or in 4.8 per cent. of all cases. The albuminuria was of renal origin and of primary appearance during pregnancy in only 7 cases. It was referable to pre-existent Bright's disease in 1 case, and to catarrhal inflammation of the urinary ducts in 21. Flaischlein[1] examined the urine of 1000 pregnant women, and detected albuminuria in 26, or in 2.6 per cent. In 5 cases it was due to vesical catarrh, in 2 cases to antecedent chronic nephritis; in 3 cases the albuminuria was transient. Out of 200 cases in the Guy's Hospital Charity,[2] albuminuria was discovered in 4, and 2 of these were probably cases of chronic Bright's disease. Out of 422 cases in Bellevue Hospital,[3] albuminuria was found in 22. Other investigators have estimated the proportion of pregnant women whose urine contains albumen at 20, and even 30, per cent. The results of the researches of Ingerslev and Flaischlein are especially worthy of credence on account of the large number of cases and the accuracy of the methods of chemical analysis.

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[1] *Obstet. Trans.*, vol. xxiv.

[2] *Ibid.*, 1887.

[3] *Loc. cit.*, p. 373.

[4] *Zeitschr. f. Geb. u. Gyn.*, Bd. vi. p. 176.

Mention has already been made of physiological albuminuria[4] as an occasional phenomenon under certain conditions in the course of pregnancy. The small quantity of albumen, the absence of tube-casts and renal epithelium, the transient character of the appearance, and the absence of all symptoms pointing to renal disturbance, are diagnostic criteria commonly sufficient to distinguish this phenomenon from albuminuria due to functional or organic disease of the kidneys. In the light of Ingerslev's and Flaischlein's observation the assertion by Behm[5] that pregnancy is invariably accompanied by albuminuria is plainly erroneous.

Etiology.—Pregnancy sustains with relative frequency a necessary relation to various forms of nephritis. A certain type of renal disease is observed only during gestation, and all the varieties of chronic Bright's disease are, as a rule, aggravated by the condition. The nature of this causal nexus, however, is still very obscure, notwithstanding the patient investigation of numerous observers from the days of Rayer[6] (1840) and Lever[7] (1842) up to the present. The subject is of vital importance, since the treatment of the condition itself and its chief symptom, eclampsia, depends almost exclusively upon the views entertained as to causation. Not one of the numerous theories which have been urged from time to time is in itself adequately explanatory of the renal complications incident to pregnancy. However, these theories are seldom contradictory propositions, and it is frequently the case that more than one etiological factor is in active operation.

1. The most ancient theory is that the albuminuria and kidney disorders are due to mechanical pressure of the renal blood-vessels, especially the veins, by the gravid uterus. Passive hyperæmia of the

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[1] *Zeitschr. f. Geb. u. Gyn.*, Bd. viii. p. 358.

[2] Galabin's *Midwifery*, p. 272.

[3] Elliott: *Obstet. Clinic*, N. S., 1868, p. 7.

[4] Leube: *Virchow's Archiv*, Bd. lxxii. p. 145.

[5] *Monatschr. f. Geb.*, Bd. xviii., Sup., p. 19.

[6] *Traité des Maladies des Reins.*

[7] *Guy's Hospital Reports*, 2d Series, 1842.

kidneys results, and this condition predisposes to, even when it does not actually excite, inflammatory changes. The chief representatives of this theory are Frerichs, Rosenstein, C. Braun, Litzmann, Cazeaux, and Möricke. Certain clinical facts lend probability to this view. Albuminuria commonly makes its appearance in the second half or during the latter months of gestation, at a time when the uterus is of sufficient size to exercise mechanical pressure. It is of relatively frequent occurrence in primiparæ who possess tense abdominal walls. In case of multiple pregnancy, hydramnion, and excessive uterine distension from other causes it is observed comparatively often. Litzmann[1] indeed goes so far as to assert that albuminuria is the rule in twin pregnancy, and that absence of this symptom establishes a strong presumption against the fact of multiple gestation. Albuminuria is frequently present in cases of large intra-abdominal[2] tumors, such as ovarian cystomata and uterine myomata.

Möricke[3] has called attention to the well-known fact that albuminuria is much more frequent during labor than during pregnancy at a time when intra-abdominal tension is greatest. This observer found pathological renal albuminuria ten times as frequent in labor as in pregnancy.

Albuminuria diminishes rapidly, as a rule, after labor. In many cases the apparent restitution to a strictly normal state occurs within twenty-four or forty-eight hours after the expulsion of the fœtus. This fact finds no analogue in the course of nephritis under other conditions.

The theory is no longer tenable that the venous stasis is caused by the pressure of the gravid womb upon the renal blood-vessels. Study of the topographical relations of the gravid womb shows that this viscus does not at any time actually compress these vessels. Moreover, Lahs' researches, already mentioned in detail, indicate that increased intra-abdominal pressure, and not pressure of the pregnant uterus, is the cause, *par excellence*, of the so-called mechanical disorders of pregnancy. Bamberger[4] in particular has called attention to this important modification of the pressure theory.

The view that venous stasis in the kidneys predisposes to, and under certain conditions actually excites, nephritis may be accepted as definitively established. Bamberger, from the investigation as to causation of 2430 cases of Bright's disease, estimates among the etiological factors valvular defects as accounting for 9.1 per cent. of the cases; pregnancy, 6 per cent.; pulmonary emphysema, 3.5 per cent.

The probability of the universal operation of this etiological factor, however, is very much lessened by the following considerations, which have been advanced by Bartels, Schroeder, Spiegelberg, Braxton Hicks, Robert Barnes, Ingerslev, Devilliers, Regnault, and others:

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[1] *Deutsche Klinik*, 1852.

[2] Bamberger: "Ueber Morbus Brightii," *Pester medecin-chirurg. Presse*, 1879, Nos. 24 and 25.

[3] *Zeitschr. f. Geb. u. Gyn.*, Bd. v. p. 5.

[4] *Loc. cit*

Morbid renal albuminuria sometimes appears early in pregnancy,[1] before any considerable elevation of intra-abdominal tension. Ingerslev found renal albuminuria, due to pregnancy, only in one primipara; on the other hand, in five multiparæ. In the five cases of twin pregnancy and three cases of hydramnion, occurring in the 600 women examined, no albuminuria was present. In 67 cases of hydramnion collected by Levison albuminuria and anasarca were present in only 2.

Flaischlein[2] has examined the urine in 28 cases of intra-abdominal tumors, and detected albumen in only 3 cases, tube-casts in 2. In the 3 cases of albuminuria, ovarian cystomata, not of the largest size, were present.

Möricke's conclusion, that albuminuria is much more frequent in labor than in pregnancy, is not fully established by his own researches, inasmuch as a sufficient number of ante-partum urinary examinations were not made. Of 153 women during labor, Ingerslev detected albuminuria in 50. The development of the albuminuria, as already pointed out by Winckel, was favored by the long duration of labor. In 80.5 per cent. of the cases the albuminuria disappeared within forty-eight hours after parturition. Ingerslev suggests the idea that labor itself may be sufficient to determine nephritis and albuminuria. But in the cases cited by this observer adequate ante-partum examination of the urine was not carried out, and the conclusion is only an hypothesis. Out of the 1000 pregnant women whose urine was tested by Flaischlein, 537—295 primiparæ, 242 multiparæ—were observed during labor. Albuminuria was detected in 93 cases—73 primiparæ and 20 multiparæ—or in 25 per cent. of the primiparæ and in 8 per cent. of the multiparæ. Except in the cases of chronic nephritis and the kidney of pregnancy the albuminuria disappeared soon after labor. These observations render in a high degree probable the hypothesis that all affections of the kidneys characterized by albuminuria, hyaline and granular casts, and fatty degeneration of the renal epithelial elements may be caused by labor itself. In the causation of this albuminuria of labor it is not improbable that a reflex contraction of the renal arteries, and consequent renal anæmia, plays an important rôle. The polyuria after expulsion of the child and the cessation of uterine contractions is evidence of secondary relaxation of the renal arteries (Flaischlein).

The disappearance of albuminuria after labor, as pointed out by Bartels, only indicates that pregnancy is its cause. It does not prov that increased intra-abdominal tension is the exclusive, or even princi pal, factor. Moreover, as pointed out by Hofmeier,[1] Ingerslev, Flaischlein, and others, in many cases the renal albuminuria due to pregnancy assumes an extraordinarily protracted course, so that the prognosis quoad valitudinem completam, so far as the kidney of pregnancy is concerned, must be very reserved.

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[1] Robert Barnes: *The Lancet*, April 29, 1865.

[2] *Loc. cit.*, p. 389.

But these considerations, it will be noted, only impair the value of the pressure theory as an adequate explanation of all the renal disorders incident to pregnancy. Now, it is not claimed by the defenders of this view that venous stasis in the kidneys is the exclusive and universal etiological factor, but only one of the principal agents. To this proposition assent cannot fairly be withheld.

2. Halbertsma,[2] in particular, has called attention to the hindrance to the discharge of urine through the ureters by mechanical obstruction due to compression by the gravid womb or catarrh of the ducts themselves. Dilatation of the ureters, retrostasis of urine, changes in the renal parenchyma, and albuminuria ensue. Halbertsma confirms his theory by changes found in the kidneys and ureters in several post-mortem examinations, as well as by certain experiments. He found that if the ureters are compressed for a length of 8 cm. by a weight of 5 grams, the pressure of a column of urine 400 mm. in height is inadequate to overcome the obstruction. Aufrecht[3] observed albuminuria and fatty degeneration of the renal epithelium after ligation of the ureters. Out of 32 cases of fatal eclampsia recorded by Löhlein,[4] dilatation of one or both ureters was demonstrated in 8, or 25 per cent. This observer concludes that in 5 of these cases an already insufficient urinary excretion was still further limited, or even entirely interrupted, by urinary retrostasis in consequence of compression of the ureters, so that urinæmia and its symptom, eclampsia, were produced. Hiller[5] regards the possibility of the operation of this etiological factor as demonstrated. Kucher[6] in his admirable treatise suggests that it would be "more in accordance with all the facts to regard the enlarging or contracting uterus as capable of producing stretching, flexure, or infraction of the ureters." Halbertsma asserts that the reason why dilatation of the ureters is not found more frequently in the post-mortem examination of women dying of renal disease during pregnancy, labor, and the puerperium lies in the fact that the characteristic anatomical changes disappear rapidly after death. It is safe to regard obstruction to the flow of urine through the ureters as one of the important factors in the

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[1] *Zeitschr. f. Geb. u. Gyn.*, Bd. iii. p. 259.

[2] *Centralblatt f. med. Wissensch.*, No. 21, 1871; *Volkmann's Sammlung klin. Vort.*, No. 212, 1882; *Arch. f. Gyn.*, Bd. xxiv. p. 303.

[3] See also Runeberg: "Analyse der klinischen und experimentellen Beobachtungen hinsichtlich der Albuminurie," *Deutsches Archiv f. klin. Medicin*, Bd. xxiii. H. 3.

[4] *Zeitschr. f. Geb. u. Gyn.*, Bd. iv. p. 88.

[5] *Zeitschr. f. klin. Med.*, 1881, Bd. ii.

[6] *Puerperal Convalescence, etc.*, 1886, p. 137.

causation of the renal disorders, although it is impossible to accept the author's view that it is the most frequent cause.

3. Scanzoni and Frerichs have emphasized the significance as an etiological factor of the hydræmic state of the blood incident to pregnancy. But renal disorders are observed with relative frequency in young robust primiparæ (Bartels, Schroeder). It is quite possible, however, that the qualitative blood-changes sustain a predisposing causal relation to the disorders under consideration.

4. Mahomed has pointed out the significance of increased arterial tension in the production of albuminuria. In the pre-albuminuric stage of Bright's disease increased arterial tension is evident. Robert Barnes is inclined to attach great importance to this factor, at least as a predisposing cause.

5. Peter, Schroeder, and others invoke increased functional activity of the kidneys during pregnancy in the explanation of albuminuria. To this theory it may be objected that the renal excretion is not greatly increased during gestation, according to the researches of Winckel and Spiegelberg. In diabetes, a condition in which the functional activity of the kidneys is greatly increased, albuminuria and structural changes are infrequent (Burkart). When the kidneys are normal as regards structure and functions, the increased work incident to pregnancy is probably not productive of untoward results. It is, indeed, highly probable, if not actually demonstrated, that a physiological hypertrophy of the organs takes place. But if, on account of congenital defect or acquired disease, the kidneys are barely equal to the work required of them in the non-gravid state, it is perfectly obvious that even a slight increase in functional activity may disturb the balance and cause a state of relative insufficiency.

6. Tyler Smith, Cohnheim, Spiegelberg, Fleischl, and others regard many cases of eclampsia as being due to renal anæmia the result of reflex vaso-motor spasm of the renal arteries, the excentric irritant being the contracting uterus. Spiegelberg refers all cases of eclampsia in individuals whose kidneys have not been previously the loci of diffuse inflammation to this category. There are many facts which lend probability to this bold hypothesis, and from the nature of the case its positive disproof in the present state of our knowledge is impossible. The full discussion of this theory, however, will be considered under the Pathology of Labor.

These, in brief, are the more important theories with reference to the causation of the renal affections incident to gestation. For the most part, they are theories resting upon facts derived from careful clinical observation and elaborate experimentation; they are seldom mere speculative hypotheses. Not one of them, however, as before remarked, constitutes a sufficient explanation of all the phenomena. But combined they afford, not indeed an adequate solution of the problem of etiology, but indications for rational and highly successful therapeusis. The late Bartels,[1] in commenting upon this topic, wrote: "For the present there is nothing left for us but to record the fact that parenchymatous inflammations of the kidneys and the liver may be developed during pregnancy, and to confess that we do not know what causes them." A just estimate of our present knowledge condemns this dictum as pessimistic.

Before leaving this subject mention may be made of a recent hypothesis advanced by A. F. A. King.[2] "Disturbances in the renal circulation and renal functions," this observer writes, "are produced chiefly by pressure of the gravid uterus upon the abdominal aorta or its branches, or upon the vena cava or its branches, or upon both or all of these, in consequence of the child and womb not maintaining during pregnancy their normal lateral obliquity above the pelvic brim." In cases in which the head and lower uterine segment have already engaged within the pelvic cavity during the latter part of gestation, King recommends lifting the lower segment of the womb and the child's head out of the pelvic cavity toward that iliac fossa opposite to the side to which the fundus is inclined.

This remarkable hypothesis rests upon the utterly gratuitous assumption that the normal presentation of the fœtus before labor begins is the dorso-anterior position of an oblique presentation. The experience of the human race from its earliest records to the present proves that lightening before labor is an absolutely physiological occurrence. The absurdity of the transformation of a normal presentation into a pathological condition—admitting the possibility of the procedure—is obvious. The hypothesis is unworthy of serious consideration.

PATHOLOGY.—The types of renal disease to which pregnancy stands in direct or indirect causal relation are numerous.

1. Under the term the kidney of pregnancy Leyden[3] has pointed out a condition peculiar to pregnancy. The kidney is relatively large and of a pale, anæmic hue. On microscopical examination the renal epithelium gives evidence of pronounced fatty degeneration. The urine contains albumen, hyaline and granular casts, and renal epithelium showing fatty changes. Œdema is commonly present. All evidence of inflammation is absent, and the structural changes are due to anæmia.

This condition is anatomically distinguished from acute parenchymatous nephritis by the behavior of the interstitial connective tissue and the characters of the urine. In the kidney of pregnancy this connective tissue is intact; in acute nephritis it is swollen, œdematous, infiltrated with small cells, and shows proliferation. Hæmaturia is characteristic of acute nephritis, while the red blood-corpuscles are notably absent in the urine of the kidney of pregnancy.

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[1] *Loc. cit.*

[2] *Am. Journ. of Obstet.*, March, 1887.

[3] *Zeitschr. f. klin. Medicin*, Bd. ii.

Acute nephritis is of more or less sudden origin, while the kidney of pregnancy is developed slowly and often imperceptibly.

The distinction between the kidney of pregnancy and chronic interstitial and parenchymatous nephritis is much more difficult. Low specific gravity, small amount of albumen, large quantity of urine, cardiac hypertrophy, and hard pulse speak for chronic interstitial nephritis. The history of the case is of especial value in the differential diagnosis between the kidney of pregnancy and chronic parenchymatous nephritis. The latter condition is frequently a sequela of inveterate syphilis, phthisis, and malaria.

The distinction between the kidney of pregnancy and the various forms of chronic nephritis is rendered still more difficult by the probable fact that the kidney of pregnancy may be the point of departure of all the types of chronic Bright's disease. Litzmann, Hofmeier, Ingerslev, Schroeder, Möricke, and others have brought forward many clinical facts which lend strong probability to this view. On the other hand, Bartels writes:[1] "A chronic affection of the kidney never follows." Leyden and Flaischlein are of the opinion that such a transition has never been demonstrated. The latter observer regards it as *a priori* improbable. The weight of probable evidence is in favor of the first view—*i. e.* that the kidney of pregnancy may pass over into chronic Bright's disease.

2. Latent chronic interstitial nephritis, chronic tubal nephritis, and lardaceous degeneration of the kidney are usually influenced unfavorably by pregnancy, and, in turn, may lead to the interruption of that state. In this connection it is necessary to bear in mind the fact to which Carl Braun[2] has repeatedly called attention, that in the severest types of Bright's disease—atrophy and amyloid degeneration—albuminuria may be entirely absent.

3. Mixed types of chronic Bright's disease are frequently observed. Thus, the interstitial and tubal forms of the disease may be combined. Amyloid degeneration may be present with either form, and fatty changes are common in all types of Bright's disease. Eclampsia is of relatively infrequent occurrence in chronic renal disease, although anasarca and its consequences may, and frequently do, lead to the interruption of pregnancy.

4. Acute parenchymatous nephritis is, of all renal disorders occurring during pregnancy, of gravest prognostic moment. Incidental mention has been made of its more important characteristics. In this form of renal disease eclampsia is of most frequent occurrence.

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[1] *Loc. cit.*, p. 216.

[2] *Loc. cit.*, p. 827.

SYMPTOMS.—The symptoms of the various renal disorders just mentioned are neither uniform nor constantly present. Anasarca frequently directs attention to the patient's condition long before the appearance of more significant signs. Œdematous swellings of the face, hands, arms, feet, legs, and labia majora are always suspicious appearances, and should lead at once to an examination of the urine and rigid scrutiny of the patient's general condition. These œdematous swellings are wandering—appear when the patient is lying down, and disappear when she rises and walks about. Sometimes, toward the end of pregnancy, they become less marked, not infrequently entirely disappearing, while the albuminuria is increasing. The skin covering the œdematous portions of the body is dry, of a chalky-white appearance, and the surface temperature is diminished.

Anomalous nervous phenomena—headache, vertigo, dimness of vision, spots before the eyes, ringing in the ears, sudden deafness, obstinate nausea and vomiting, insomnia, neuralgias, and the like—are often observed. These various nervous phenomena are symptomatic of urinæmia.

Convulsions, due to renal insufficiency conditioned upon functional or organic disease of the kidneys or upon urinary resorption from obstruction of the ureters, may occur during pregnancy, but are more frequently observed during labor.

All the renal disorders incident to pregnancy strongly predispose to abortion or premature labor. This topic, however, will be fully discussed in a succeeding section.

The DIAGNOSIS and PROGNOSIS of the renal disorders of pregnancy will be discussed in connection with the subject of eclampsia in a subsequent section.

TREATMENT.—In view of the serious complications arising during pregnancy, labor, and the puerperium from interference with the functions of the kidneys, the absolute necessity of chemical analysis of the urine at regular intervals in every case, especially during the latter half of gestation, is apparent. Evacuation of the uterine contents—that is, the removal of the cause—is the only means of effecting a radical cure. However, before resorting to this procedure, a variety of expedients, hygienic and medical, must be invoked in the palliation of the morbid conditions.

*Hygienic.*—The diet should be restricted to milk and non-nitrogenous foods, so far as this may be possible. The functional activity of the skin can be maintained and rendered in a very high degree compensatory to the diminished renal action. This constitutes by far the most important objective point in treatment. The systematic use of the hot-water bath[1] fulfils the indication just mentioned more adequately than any other single therapeutic agent. This very ancient method of treating renal disorders is practised with great technical perfection in Vienna. Breus[1] has well described the method as it is seen in almost daily operation in the lying-in wards of Carl Braun, Breisky, and Gustav Braun. The patient, entirely nude, is immersed up to the neck in a portable bath of a temperature of about 102° Fahr. The tub is covered with heavy woollen blankets which permit the head to protrude. The temperature of the water is then gradually elevated to 110° or 112° Fahr. An ice-bag or a linen cloth wrung out of cold water applied to the head relieves the annoying cephalic symptoms which are occasionally observed at this time. Thirst is relieved and diuresis and diaphoresis promoted by the copious imbibition of water. The patient remains in the bath about thirty minutes. She is then removed, wrapped in hot sheets, and put to bed between two layers of heavy woollen blankets, and covered in so that only the face is exposed. Profuse sweating soon begins, and is kept up for two or three hours. After this vigorous sweating the patient commonly falls into refreshing slumber. If she feels faint in the bath or bed, a glassful of one of the light native wines usually restores the circulatory equilibrium. Great care is taken in the gradual cooling off of the surface when the woman rises from the bed. According to the indications in the concrete case the bath is repeated from once to twice daily for an indefinite period. Under this simple mode of treatment wonderful results are frequently noted. The troublesome headache is relieved, dropsical effusions abate, and the amount of albumen in the urine is diminished.

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[1] Liebermeister: *Prager Vierteljahrsschrift*, 1861.

The query as to the effect of hot-water baths on uterine contractions naturally arises. Hot-water sitz-baths have been used for years in all the Vienna lying-in clinics as a simple, innocent, and efficient means of stimulating uterine contractions in tardy labors. On *a-priori* grounds it would seem in a high degree probable that the calling of all the skin reflexes into functional activity might result in the invocation of expulsive efforts of the womb. Breus was unable to observe any such effect, but chloral was at the same time exhibited per rectum in many of the cases. A. Sippel[2] has reported two cases of severe Bright's disease during pregnancy, with threatened eclampsia, in which the hot-water bath was used. In both cases premature labor followed the bath and diaphoresis within, respectively, fourteen and one and a half hours. To determine the effect of hot-water baths on the normal pregnant woman, Sippel selected a woman pregnant in the thirty-fourth week. She had a generally contracted pelvis, and the induction of premature labor was indicated. After baths on two successive days, without the subsequent packings, sensible uterine contractions occurred, but gradually passed away. On the third morning pains commenced during the bath, and labor terminated normally some twenty-four hours later. In a second case[1] the effect of the bath was less marked. The writer has recently observed the induction of premature labor immediately following the hot-water bath in two cases of Bright's disease in pregnancy, with threatened eclampsia.

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[1] *Arch. f. Gyn.*, Bd. xix. p. 219.

[2] *Centralb. f. Gynäk.*, No. 44, Oct. 31, 1885.

The possibility of the induction of premature labor by the hot-water bath must be admitted. This tendency may be limited by the exhibition of chloral and the bromides. However, the spontaneous evacuation of the uterine contents under these conditions in the majority of cases is an event for which the obstetrician most devoutly prays, so that the possibility of the premature interruption of pregnancy seldom constitutes distinct contraindication to the employment of this mode of treatment. As a method of induction of premature labor the hot-water bath is entirely devoid of danger from sepsis. Further trial, however, is necessary to determine its efficiency.

In lieu of suitable appliances for the hot-water bath, an efficient vapor bath can always be readily extemporized. A spirit-lamp and a large tin funnel with a long bent beak constitute the necessary parts of the apparatus. The patient is well wrapped up in bed, the beak of the funnel introduced beneath the bed-clothes, and the lighted lamp placed under the expanded portion of the funnel. When the lamp is large enough and the beak of the funnel is not obstructed by the bed-clothes, the space immediately about the patient is soon filled with hot air and aqueous vapor.

The lateral or latero-prone posture during sleep serves to relieve in some degree the ureters of the pressure from the gravid womb, and should be advised. Graily Hewitt, Löhlein, and Routh speak highly of this postural treatment. The genupectoral posture is doubtless much more efficient in removing pressure from the ureters, and its systematic employment merits recommendation. Postural treatment is of value before engagement of the head and lower uterine segment within the pelvic inlet. It is plainly of relatively slight importance in the diminution of intra-abdominal tension.

*Medical.*—The exhibition of non-irritant diuretics, such as the acetate and bitartrate of potassium, in large quantities of water, causes an increased secretion of urine and lessens renal congestion. Among mineral waters, Bilin, Giesshübel, Preblau, Selters, and Vichy deserve mention. The tincture of the chloride of iron in the form of Basham's mixture, and the fresh infusion of digitalis in connection with the potassium salts already mentioned, are the usual and most reliable combinations.

Cathartics which produce large, watery stools without much irritation supplement the action of diuretics and diaphoretics. Castor oil, the salines, and calomel, alone or in combination, commonly fulfil this indication. Elaterium, the most efficient of all hydragogue cathartics, must be used with extreme care.[1] In properly-regulated doses it produces the freest evacuations with relatively little pain and irritation. Undoubtedly, it aids in the elimination of the excrementitious matters retained within the blood. Its action, however, is exhausting, and there is considerable danger of the premature interruption of pregnancy from the drastic effects of too large a dose. It is usually safe to commence with a half grain of the trituration (U. S.), combined with one grain of the extract of hyoscyamus and a drop of one of the aromatic oils. The use of this drug is rightly restricted to the severer cases, in which symptoms of urinæmic intoxication have already appeared.

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[1] *Centralb. f. Gynäk.*, April 3, 1886, No. 14.

Jaborandi and pilocarpine are justly regarded as the most reliable and influential of diaphoretic drugs. Nevertheless, the weight of evidence is decidedly against their use in the renal complications of pregnancy. Competent testimony shows that these remedies in the renal disorders of pregnancy are uncertain in action; they often act as cardiac depressants, and frequently stand in a causal relation to pulmonary œdema. Then the effect of the drugs upon the kidney itself is a matter of moment. Purjesz[2] has noted the occurrence of albuminuria after the exhibition of pilocarpine; Wood and Stumpf have observed strangury. The drug possesses important oxytocic properties, which will be mentioned in connection with the artificial induction of abortion. In the present state of our knowledge the use of this drug is distinctly contraindicated. The same effect, with no risks, can be secured by the hot-water bath.

By a judicious combination of these varied therapeutic resources threatening symptoms may commonly be averted and the pregnancy carried along at least until the fœtus is viable, and until a time when labor may be induced with a reasonable hope of saving the child's life; that is, until the thirty-sixth week. Not infrequently, however, notwithstanding all efforts, the albuminuria steadily increases, hydræmia becomes more marked, hydropsies appear with alarming cerebral, cardiac, or pulmonary symptoms. More active treatment is indicated, and the artificial interruption of pregnancy comes up for consideration. Without entering into a discussion of the arguments for and against this procedure, let it suffice to say that clinical experience furnishes overpowering evidence in favor of the operation. When shall pregnancy be artificially interrupted? The artificial induction of abortion is very rarely indicated, since the renal disorders occur in the very large majority of cases during the second half of pregnancy, and particularly during the last three months. The exact indications will be stated in connection with

[1] H. C. Wood: *loc. cit.*, p. 517.

[2] *Deutsch. Archiv klin. Med.*, xvii. p. 533.

the subjects of Premature Labor and Abortion. But here it may be said that when, in the concrete case, after a careful, systematic use of the therapy just outlined, especially of the hot-water bath, the symptoms do not abate, the artificial evacuation of the contents of the uterus is indicated. It is very much wiser to err in the interpretation of the indications on the side of too early operative interference than to temporize until prodromes of eclampsia or pericardial effusion occur.

## SKIN DISEASES.

*Impetigo Herpetiformis.*—Under this term Hebra[1] in 1872 described a rare skin disease, supposed to be peculiar to pregnancy, of which he encountered five examples. Grouped pustules, the size of the head of a pin, upon inflamed bases, appear in the groin, around the umbilicus, over the breasts, in the axillæ, later on other surfaces. Within one or two days these pustules dry up into dirty-brown crusts, while around them new pearl-like pustules develop in circles, which in turn dry up and increase the size of the central scab. The efflorescence is thus diffused by successive crops over the entire skin surface within a period of from three to four months. The mucous membrane of the tongue, palate, velum, posterior wall of the pharynx, and the œsophagus sometimes shows circumscribed, gray, centrically-depressed plaques. Rigors, a high remittent fever with exacerbations as new crops appear, great prostration, delirium, vomiting, characterize the disease. In one case Kaposi has noticed a prodromal erythema læve et urticatum.

The disease occurs commonly during the second half of pregnancy. As before remarked, Hebra describes the disease as peculiar to pregnancy. Kaposi[2] and Patoky, however, have observed the affection in two young men, aged respectively twenty and eighteen years. Friedr. Schwarz has seen one case in a non-pregnant woman. On account of the apparent influence of gestation in the development of the disease, it has been customary to regard impetigo herpetiformis as a neuro-reflex dermatosis analogous to pemphigus hystericus, herpes gestationis, and the like.

Neumann regards the disease as metastatic pustulosis. The large numbers of cocci, bacteria, and vibriones in the contents of the pustules, the eruption suggestive of metastasis, the high fever, and the fatal course point to the existence of an infectious disease.

Two cases observed by C. Heitzmann and Fr. Schwarz are of interest, since they indicate a certain analogy, if not an actual relation, between the disorder under consideration and pemphigus. In both of these cases, after the disappearance of impetigo herpetiformis Hebra, a rapidly fatal pemphigus was developed.

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[1] *Wiener med. Woch.*, No. 48, 1872.

[2] *Pathologie und Therapie der Hautkrankheiten*, 2te Hälfte, Wien, 1887, p. 547.

The PROGNOSIS is unfavorable. Out of 12 cases recorded in the Annals of the Vienna Dermatological Clinic, 10 terminated fatally during pregnancy. In one case the disease appeared in two pregnancies succeeding each other at brief intervals, completely disappearing in the interim. The disorder terminated in death during the third gestation. Recidiva are liable to occur. In one of the cases cited the woman apparently recovered, but within a few weeks the disease reappeared, and was followed by death. Only one case of permanent recovery is registered. The interruption of pregnancy apparently exercises no influence upon the course of the affection.

*Herpes Gestationis.*—Milton and Bulkley have observed and described, as peculiar to pregnancy, a pemphigoid efflorescence which they have designated herpes gestationis. Erythema, papules, vesicles, and bullæ are developed. Vesicles predominate, appearing first on the lower extremities, subsequently spreading over the body. Intense itching and burning attend the eruption. Urticaria, neuralgia, and other neurotic symptoms accompany or precede the development of the affection. The disease appears early in pregnancy, continues until term, disappears after labor, but is apt to recur with succeeding pregnancies. The constitutional symptoms are much less severe than in the impetigo herpetiformis of Hebra.

It is in a high degree probable that herpes gestationis is a reflex neurosis analogous to pemphigus hystericus, the peripheral irritant being the germinal mass in the uterus, the sensory, vaso-motor, and trophic nerves being the conductors.

The PROGNOSIS is favorable and the TREATMENT symptomatic.

*Dermatitis Herpetiformis.*—Duhring[1] regards both of the skin affections first mentioned as different manifestations of the same general process, which he terms dermatitis herpetiformis. Against this view numerous objections have been forcibly urged. As remarked by Kaposi, "This designation represents no well-characterized clinical picture, but merely a purely theoretical formula." It would throw together a number of diseases whose clinical course, diagnosis, and prognosis are essentially different, whose causes are in some ca known, and in others—as in impetigo herpetiformis—totally unknow

*Pruritus.*—General pruritus, without any apparent skin lesion, is rare disease of pregnancy, and is referred by Hebra to the class of idi neuroses.[2] Maslieurat-Lagemart observed a case in which gener pruritus was developed in eight successive pregnancies, and becam so intense that premature labor was induced. Spiegelberg narrates th history of an elderly primipara in whom pruritus was developed a the second month. The patient became so enfeebled, despite all treatment, at the end of the fifth month as the result of loss of sleep tha the artificial termination of pregnancy was considered. However, she was delivered at the thirty-seventh week of a healthy child. In both of these cases the disease only appeared during pregnancy, and promptly disappeared with its cessation.

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[1] *Journ. Cut. Dis.*, Oct., 1885, p. 317.

[2] Cazeaux: *loc. cit.*

In the TREATMENT of this affection Cazeaux recommends highly alkaline baths (potassium carbonate, 150 grams to a large bath). Cocaine has also been employed with advantage.

*Pruritus Vulvæ.*—Itching about the genitalia in either sex, as remarked by Duhring, always demands a careful ocular examination of the parts. The symptom is commonly due to one of three conditions—eczema, pruritus, or phthiriasis pubis. The relation of diabetes mellitus and acrid vaginal secretions is well known.

The TREATMENT of course must be directed to the removal of the cause. This important topic will be considered fully in connection with the diseases of the genital apparatus during pregnancy.

## NEUROSES.

Of all the neuroses in the course of pregnancy, eclampsia is of chief clinical significance. Puerperal convulsions, however, occur with greatest relative frequency during labor. For this reason the subject is usually discussed in connection with the pathology of parturition and the puerperium. The various psychoses are referred for a similar reason to the same article.

*Tetany.*—As defined by Berger,[1] tetany is a spastic neurosis occurring most frequently during childhood and youth, characterized by paroxysmal bilateral tonic convulsions, involving definite groups of muscles of the extremities, without alteration of consciousness, and highly increased irritability of the peripheral motor nerves upon the application of electrical and mechanical stimuli. The disease is almost always curable; a definite, anatomical basis up to the present time has not been found.

The etiology of tetany is very obscure. Trousseau asserted that pregnancy stood in a necessary relation to the disorder. Meinert, however, has been able to collect only six cases of the affection in pregnancy from the literature of the subject. Two cases were observed in I.-paræ, one in III.-para, and one in VI.-para; the ages in the six cases cited were, respectively, twenty-one, thirty-two, thirty-three, thirty-four, forty, and forty-two years. The attacks begin at all periods of gestation, and the symptom recurs in succeeding pregnancies.

The prodromes are general sensations of malaise and discomfort, with pains especially in the arms. The convulsions commonly commence in the upper extremities, and spread centripetally from the fingers to the trunk. The toes are first affected when the symptom is observed in the lower extremities. Trousseau's phenomenon—the contracture of the fingers, "like the hand of the obstetrician about to enter the vagina" —is measurably characteristic.

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[1] Meinert: "Tetanie im der Schwangerschaft," *Archiv f. Gyn.*, Bd. xxx. H. 3, p. 444.

The increased irritability of the peripheral motor nerves can be demonstrated by the application of electrical and mechanical stimuli over the course of the facial and median nerves. During the pauses between the spasms such irritants are sufficient to provoke new convulsions. Meinert has observed trophic disturbances of the nails in a single case.

The PROGNOSIS is favorable. The disease commonly ceases with pregnancy, although it frequently makes its primary appearance during the puerperium.[1]

In the TREATMENT of the condition it is necessary to eliminate all peripheral irritants—tænia and the like—and subsequently to place chief reliance upon chloral and the bromides.

*Tetanus.*—Tetanus, a rare affection, especially in women, is occasionally observed after abortion or labor at term. Sir James Y. Simpson has collected 27 cases, in 22 of which the disease was fatal. Bennington records 41 cases, with fatal termination in 37; in 21 of these cases tetanus followed abortion. The disease occurs with greatest relative frequency in hot climates after abortion and the removal of decidual and placental remains. Wiltshire, who reports two fatal cases, expresses the view that the retention of a portion of the fœtal envelopes may act as a causal factor in two ways: (1) by its presence as a foreign body; (2) when infected by causing a peculiar form of septicæmia.

*Chorea.*—Chorea is a relatively infrequent complication of pregnancy. Robert Barnes (1868) has collected 56 cases from the literature of the subject; Fehling[2] (1874) brings the number up to 68; Spiegelberg (1882) to 84.[3]

The disease is of most frequent occurrence in primigravidæ; out of 45 cases, Barnes found 28 primiparæ; Fehling, out of 53 cases, 33 primiparæ. The disease is liable to recur with succeeding pregnancies, more or less completely disappearing during the intervals. It makes its appearance commonly during the first half of pregnancy: Barnes has noted this fact in 29 out of 30 cases; Fehling, in 39 out of 55 cases.

The facts at present known with reference to the causation of the chorea of pregnancy are, briefly: (1) There is usually a predisposition to the affection, inherited or acquired; (2) inanition of the central nervous system incident to the hydræmic state of the blood in pregnancy; (3) various potential peripheral irritants in connection with the sexual organs. As remarked by Wood,[1] "The most rational explanation of the chorea of pregnancy is that it varies in its immediate pathology, the pregnancy simply producing a condition of the nervous system which predisposes it to be thrown into active chorea by various exciting causes."

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[1] Ehrendorfer: "Tetanie im Wochenbett," *Wiener med. Wochenschr.*, 1883, No. 1.

[2] *Arch. f. Gyn.*, 1874, Bd. vi. p. 137.

[3] For 3 additional cases see Osler, *Medical News*, Oct. 22, 1887, p. 465; Wasseige, *Bull. de l'Acad. Royal de Méd. de Belgique*, t. i., 1887; Hirst, *Trans. Philada. Obstet. Soc.*, Dec., 1887. See also Hervé, "De la Chorée pendant la Grossesse," *Thèse de Paris*, 1884; and Gayard, *Contributions à l'Étude de la Chorée des Femmes enceintes*, Paris, 1884.

The affection is frequently a grave complication. The movements may become so violent and incessant that the patient is deprived of sleep, and death from exhaustion threatened. The convulsive character of these movements is most marked during the uterine contractions of labor (Spiegelberg, Goodell, Mosler).

Pregnancy is prematurely interrupted in about one-half the cases. The child may be born alive and affected with the disease.

PROGNOSIS.—Out of the 84 cases cited, 23 terminated in death, chiefly as the result of complications. Mania, loss of memory, grave cerebral and spinal lesions, are occasionally traceable to this affection.

TREATMENT.—The palliative treatment of the chorea of pregnancy is unsatisfactory in the extreme. All the so-called specifics of greater or less value in the non-gravid state are frequently without influence during gestation. In over one-half of the recorded cases the most judicious combination of hygienic and medical resources have proved of no avail. In view of the prognosis, the induction of premature labor is very frequently indicated, in the interest both of the mother and the child, at an early stage of the disease. Less often the question of the artificial induction of abortion comes up for consideration. In view of the grave cerebral and spinal lesions which may result from the affection, the mother is justly entitled to the benefit of the doubt. The interruption of pregnancy, however, is not invariably followed by amelioration of the symptoms. In a case reported by Goodell the disease continued and terminated in death, notwithstanding the evacuation of the uterine contents.

Wade in one case practised Copeman's method of cervical dilatation, with apparent benefit.

*Epilepsy.*—Epilepsy is commonly an accidental complication of pregnancy. Spiegelberg is responsible for the observation that in chronic epilepsy pregnancy sometimes favorably modifies the course of the disorder. The seizures occur less frequently and are not so violent in character.

Acute epilepsy may be developed as the result of pregnancy when a latent predisposition, inherited or acquired, exists. The epileptogenous zone in this form of the disease frequently comprehends the distribution of the ischiatic nerve.

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[1] *Nervous Diseases*, 1887, p. 158.

The occurrence of acute or chronic epilepsy during pregnancy is of great diagnostic interest, from the resemblance of the epileptic seizures to the convulsions caused by urinæmia. The urine secreted during or after a fit may or may not contain albumen. The diagnosis is cleared up by the history of the case and the course of the affection.

### Disorders of the Special Senses.

Disorders of the special senses in pregnancy are commonly symptomatic of renal disease. Apart from the disorders dependent upon lesions of the kidneys, disturbances of vision are of chief clinical interest. Amblyopia, hemeralopia, and color-blindness are occasionally observed as the result of nutritive disturbances in the retina.

The prognosis, as a rule, is favorable. The visual disorders commonly disappear during the puerperium and evince no tendency to recurrence.

## II. THE PECULIARITIES OF CERTAIN ACCIDENTAL ACUTE AND CHRONIC DISEASES OCCURRING IN THE COURSE OF PREGNANCY.

It was formerly thought that the pregnant woman not only enjoyed a certain immunity from accidental diseases, but also that the course of such affections was favorably modified by gestation. Modern research, however, has abundantly demonstrated the groundless nature of this belief. It is a fully-established truth that pregnancy confers upon the individual no immunity from the disorders to which the non-gravid woman is liable Moreover, such accessory diseases are commonly aggravated by pregnancy, and in their turn unfavorably influence the course of gestation, often leading to its premature interruption.

### Acute Infectious Diseases.

Of all the diseases occurring accidentally in the course of pregnancy, the acute infectious disorders are of the gravest clinical significance. These diseases are peculiarly dangerous complications for two reasons:

I. They have a marked tendency to cause the death of the fœtus, and consequently the interruption of pregnancy, at a time when the loss of blood and the muscular exertion necessary to the expulsion of the product of conception seriously imperil the mother's life.

The death of the fœtus, and the consequent interruption of p[illegible]egnancy, may result from the operation of a variety of etiological fact[illegible]ors.

1. The fœtus commonly dies in consequence of the elevatio[illegible] of maternal temperature. The case is a veritable example of the co[illegible]tion which H. C. Wood terms heat-stroke. The fœtus in its membra[illegible]

surrounded by maternal tissues, must possess at least the same temperature as the maternal body. But then it has its own heat-producing apparatus in addition, so that the assumption of the elevation of the fœtal above the maternal temperature is justified on *a-priori* grounds. Wurster has actually demonstrated the truth of this assumption. He placed a thermometer in the anus of a fœtus presenting by the pelvis, and one in the vagina of the parturient woman, and observed a difference of half a degree in favor of the fœtus. D'Alexeef's observations in eight cases—four pelvic, four face presentations—confirm the results arrived at by Wurster. In these cases one thermometer was inserted either into the anus or the mouth of the child. Fehling found the difference in the temperature less marked.

A very slight elevation of the maternal temperature produces a disproportionate rise in the temperature of the fœtus. Kaminski[1] has shown that an elevation of maternal temperature to 104° Fahr. imperils fœtal life. Increased frequency of the fœtal heart-beats and abnormally active fœtal movements are followed by diminished cardiac and muscular activity, and the fœtus dies (Hohl, Fiedler, Winckel, Hüter). Max Runge[2] has confirmed Kaminski's observations, and concludes that the maternal temperature absolutely fatal to the fœtus in rabbits is 106.7° Fahr. Doléris[3] and Doré,[4] however, have pointed out that the rapidity with which the maternal temperature is elevated plays an important rôle in the causation of fœtal death. If the temperature of the rabbit be slowly raised, even to 109.4° Fahr., and not kept at this degree too long a period, no unfavorable effect upon the fœtus is noticeable. Runge[5] has recently accepted these criticisms.

2. Pregnancy may be prematurely interrupted, independently of the condition of the fœtus, as the result of the thermic irritation of the uterine musculature by the maternal blood. Spiegelberg on *a-priori* grounds asserted the possibility of this event. Runge's experimental investigations render the view in a high degree probable.

3. The fœtus may perish from asphyxia when the maternal blood-pressure is seriously lowered. This change in the maternal vascular tension commonly results from diminution in the force and frequency of the heart's action observed in the course of acute infectious diseases or from sudden loss of blood. Asphyxia may also be caused by structural changes in the epithelium covering the fœtal placenta, due to the elevated temperature and other alterations of the maternal blood.

4. The fœtus may perish in consequence of infection with the specific *materies peccans* of the acute disorder. Thus, it has been demonstrated

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[1] *Moskauer med. Z.*, 1867, Nos. 13-19.

[2] *Arch. f. Gyn.*, Bd. xii.

[3] *Soc. de Biologie*, 1883, Nos. 28, 29.

[4] *Arch. de Tocol.*, 1884, Mars et Avril.

[5] *Arch. f. Gyn.*, Bd. xxv. Heft. 1.

that the fœtus in utero may be infected with measles,[1] scarlet fever,[2] erysipelas,[3] typhus,[4] relapsing fever, smallpox, intermittent fever, syphilis, anthrax, and other diseases.

II. Hemorrhagic endometritis, caused in part by changes in the constitution of the blood, is not an infrequent symptom in the course of acute infectious diseases in the non-pregnant woman. In pregnancy, however, this symptom is of more constant occurrence, just as it is of graver prognostic moment with reference to the mother. Its import as a cause of abortion or premature labor, and therefore its prognostic moment so far as the fœtus is concerned, is obvious. Thus, Slavjansky[5] has pointed out the relatively frequent occurrence of hemorrhagic decidual endometritis in cholera. Following hemorrhage into the decidua, according to the time, site, and extent, pregnancy may be immediately interrupted, or secondarily as the result of the pathological changes in the placenta or membranes induced by the extravasated blood. The hemorrhage may be so severe as to jeopardize immediately the life of the mother.

Of the eruptive fevers, smallpox, scarlet fever, and measles are of especial clinical interest. Smallpox is observed most frequently. The eruptive fevers usually occur early in pregnancy, but the disposition to the severer forms and the mortality, as remarked by Spiegelberg, increase with the duration of pregnancy.

*Smallpox.*—Curschman[6] is of the opinion that the condition of pregnancy predisposes in a certain degree to infection with smallpox. The mutually unfavorable relation between variola and gestation consists chiefly in the distinct tendency to the hemorrhagic form of the disease. The maternal mortality is dependent, among other conditions, upon the nature of the epidemic influence. In support of this proposition Corradi quotes Esterle, who observed no deaths nor miscarriages in 15 cases of variola, while in the epidemic of 1870–72 at Milan almost all the pregnant women aborted and 5 out of 17 mothers died. Sangregorio[7] reports 65 cases of smallpox in pregnancy, 1884–87, with miscarriage in 30 and death in 26. In 40 cases of mild smallpox, 3 died and pregnancy was interrupted in 10. Out of 22 cases of confluent smallpox, 20 died, and pregnancy was interrupted in 17 before death. In 3 cases of the hemorrhagic form of the disease all died after abortion.

The outlook with reference to the fœtus is, of course, more unfavorable than the maternal prognosis. In the class of cases in which a living and viable fœtus is born the influence of the disease is interesting and instructive. The child may be born with characteristic variolous cicatrices or in the eruptive stage, or the efflorescence may make its appearance a short period, eight to ten days, after birth. The fœtus may be infected in utero, while the mother gives no apparent sign of the disease (variola sine exanthemate—Curschman). Fumée reports a remarkable case of twin pregnancy in which only one of the children gave evidence of the disease. Finally, in very rare cases the child may escape infection altogether.

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[1] Gautier: *Annales de Gyn.*, 1879.

[2] Kaltenbach: *Centralbl. f. Gyn.*, 1884, No. 44.

[3] Lebedeff: *Zeitschr. f. Geb. u. Gyn.*, Bd. xii. p. 321.

[4] Strauss and Chamberland: *Archives de Physiol.*, 1883, i.

[5] *Arch. f. Gyn.*, iv. p. 285.

[6] *Ziemssen's Handbuch.*

[7] *Transactions of the Italian Medical Association*, section on Obstetrics, 1887.

Varioloid is of much more favorable prognostic moment, both with reference to the mother and the child, the interruption of pregnancy and maternal death being exceptional events. Loth Mayer notes 4 abortions in 37 cases; Welch, 3 in 26; Sangregorio, 1 in 7.

During smallpox epidemics abortions and premature labors, accompanied by abnormally severe hemorrhages, are frequently observed when no exanthem or other sign of the disease is noticeable in the mother. The healthy child of a woman affected with variola in the course of pregnancy is commonly insusceptible to vaccinia for a long period after birth.

PROPHYLAXIS.—In the event of a smallpox epidemic the vaccination or revaccination of pregnant women is urgently indicated. The effect of the vaccination of the pregnant woman upon the fœtus is still a subject of controversy. Thorburn (1870) successfully vaccinated a number of pregnant women, and found no insusceptibility to vaccinia in their children. Behm[1] concludes after a thorough investigation of the subject that "intra-uterine vaccination is possible but seldom." The rule in practice is obvious. It is necessary to vaccinate newborn children even when the mother has been successfully vaccinated or revaccinated during pregnancy, or even when she has passed through variola during gestation.

Pregnant women, irrespective of protection by vaccination or a previous experience of the disease, must be prevented, as far as possible, from coming within the sphere of infection of smallpox.

*Measles.*—Rubeola, of infrequent occurrence in the adult generally, is a very rare complication of pregnancy. Bourgeois records 15 cases; Gautier, 11; Jacquemier, Cazeaux, Grisolle, Bleynie, Underhill, Parvin, Schroeder, and others have described isolated cases. The disease is of important prognostic moment with reference to the mother, on account of the tendency to the hemorrhagic form of the disease and the danger of pneumonia. In 8 out of the 15 cases recorded by Bourgeois, pregnancy was interrupted. The disease is capable of transmission from the mother to the fœtus in utero. In Parvin's[2] case the patient was in the ninth month of pregnancy; "premature labor skin and mucous membrane, swelling, œdema, eczema, follicular abscesses, and necrosis of the connective tissue. The intensity of the initial lesions is due to the anatomical relations of the genitalia during pregnancy and to the greatly increased nutritive activity of the parts.

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[1] *Zeitschr. f. Geb. u. Gyn.*, Bd. viii. p. 18.

[2] *Loc. cit.*, p. 225.

The consecutive symptoms are unusually mild. The progressive glandular infiltration proceeds slowly from the genitalia, while the erythema is of short duration, and may remain confined to the skin covering the mammæ and anterior abdominal wall. Affections of the palate, tonsils, and pharynx, laryngitis, iritis, alopecia, are observed with comparative infrequency. Syphilitic fever is seldom observed. Bäumler,[1] indeed, is of the opinion that pregnancy exerts an unfavorable influence upon the course of syphilis. Sigmund's observations, however, are conclusive upon this subject.

The prognosis with reference to the child is more favorable in syphilis acquired during pregnancy than when the disease exists before impregnation. According to the observations of Mewis,[2] about one half the pregnancies continue until term. The nearer term that syphilis is acquired, the greater is the probability that pregnancy will not be prematurely interrupted. Mewis is responsible for the assertion that syphilis acquired during the first six months is much more prejudicial to the fœtus than when infection occurs later.

Infection of the child may occur during its passage through the parturient canal in labor, as in the case recorded by Weil.[3] This mode of infection is highly exceptional.

*Constitutional Syphilis.*—The influence upon the fœtus of syphilis acquired before pregnancy, and which has become constitutional, is marked and always unfavorable. The fœtus may be infected through the ovum or the spermatozoid. The infection may be transmitted from the mother through the placenta to the child, and, on the other hand, from the latter to the former through the same medium.

The following propositions, substantially those formulated by V. Bärensprung in 1864, may be accepted as approximately true:

1. When the mother is perfectly healthy, but the father is affected with constitutional syphilis, the fœtus is infected by the spermatozoids. The intensity of the fœtal disease will depend upon the age and latency of the paternal affection. The disease may be communicated to the mother by the fœtus in the mode termed by Ricord and Diday *choc en retour*, without the appearance of the primary lesion and without mar[illegible] external manifestations. The severer cases of hereditary syphilis [illegible]quently originate in this manner.

2. Women affected with constitutional syphilis are less liable to c[illegible]

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[1] *Ziemssen's Handbuch.*

[2] *Zeitschr. f. Geb. u. Gyn.*, Bd. iv. p. 1[illegible]

[3] *Deutsche Zeitschr. f. Pract. Med.*, 1877, No. 42.

ceive than perfectly healthy individuals. When conception does occur, the ovum is infected before its fertilization. The fœtus commonly dies in utero or is prematurely expelled.

3. When both parents are affected with constitutional syphilis, the disease is communicated to the fœtus as indicated in the first proposition. When the parental disease is old and latent, an apparently healthy child may be born, and under exceptionally favorable conditions the disease may not be transmitted at all. Evidences of hereditary syphilis, however, are usually manifested before puberty.

4. According to the intensity of the infection, the fœtus dies in utero, causing abortion or premature labor, or is born alive with manifestations of hereditary syphilis, very seldom acquired, or may first give evidence of the inheritance of the disease after a variable interval of from weeks to months.

The important question in practice, Whether an apparently healthy woman who has given birth to a syphilitic infant may be permitted to suckle her child? can usually be answered in the affirmative. In such cases the maternal disease may commonly be assumed to exist, but to be latent. As remarked by Zweifel,[1] only 3 cases are recorded in which the child under these conditions, has infected the mother. According to the so-called Colles' law, infection of the mother under these conditions never occurs. The apparently healthy child of a woman who has acquired syphilis late in pregnancy ought not to be suckled by the mother, since it is quite possible that the infant may have escaped infection.

TREATMENT.—Fortunately, syphilis as a complication of pregnancy is usually a very tractable affection. The premature interruption of gestation and the effect of the poison upon the fœtus may be favorably modified in the large majority of cases by appropriate specific treatment. Mercurial inunctions are preferable to the exhibition of the remedy *per os*. Iodide of potassium must be used with extreme caution, on account of its effect in the provocation of uterine contractions. The local primary or consecutive lesions deserve attention, since the child may be infected during its passage through the parturient canal.

## DISEASES OF THE HEART.

The mode in which pregnancy, parturition, and the puerperium exert an unfavorable influence upon chronic heart diseases is still the subject of much difference of opinion. Spiegelberg accounts for the disastrous results attending aortic insufficiency, observed especially in the second half of pregnancy, on the ground of inadequate compensatory hypertrophy of the left ventricle. The intercalation of the placental circulation, the increase in the blood-mass, blood-pressure, and toxæmia within a few hours of its birth. Goth found the average weight of mature children born of mothers infected with malaria to be 2936 grm., while the average weight of children born of perfectly healthy women in the same clinic was 3605 grms. The mortality of such children, moreover, was found to be much greater.

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[1] *Lehrb. d. Geburtshülfe*, 1887, p. 285.

The influence of malarial affections upon labor and the puerperium will be fully considered in another article. During the puerperium the paroxysms lose something of their rhythmical character. Chills are of irregular occurrence, and the fever assumes a remittent or continued type.

Malarial fever during pregnancy in very rare cases assumes a pernicious type, and then may stand in a certain causal relation to the essential anæmia of pregnancy, of which mention has already been made.

In the TREATMENT of malarial affections during pregnancy the same principles obtain as in the non-gravid state. Large doses of quinine are indicated. Spiegelberg points out the important fact that owing to the impairment of the digestive and assimilative functions only a portion of the quinine is absorbed. The notion that quinine is an abortifacient is as old as the medical history of the cinchona alkaloids. The researches of Chiara, Bompiani, Henry F. Campbell, Fordyce Barker, Howard, Tarnier, Deboué, Budin, and others prove that quinine, even in the largest therapeutic doses, is not abortifacient in malarial fever nor in health.

*Yellow Fever.*—S. M. Bemiss[1] of New Orleans draws the following conclusions with reference to the relations between yellow fever and pregnancy, from personal observation:

1. "Pregnant women are neither more nor less liable to the disease than the non-gravid.

2. "When pregnant women are attacked by yellow fever the danger of fatal results is so much increased that one might almost say it is exceptional for recovery to occur. But this strong statement of danger ascribable to pregnancy is applicable to severe epidemic visitations, and includes all cases treated in hospitals and in the various social conditions of private practice. In recalling the events which have occurred in the ordinary run of private practice in the best districts of this city, I can safely say that I have not lost over 33 per cent. of pregnant patients. This is something more than double the percentage of mortality of the non-pregnant. We may therefore safely postulate the danger to the pregnant woman as being double that of the non-gravid.

3. "The dangers attending pregnancy are to be ascribed to the great liability to abortion and death from hemorrhage. Perhaps liability to

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[1] Parvin: *Science and Art of Obstetrics*, p. 222.

suppression of renal secretion and death from uræmia may also be greater. Embolism and thrombosis are quite common events in protracted cases of yellow fever, but I have no recollection of such accidents in any pregnant woman in my practice.

4. "The pregnant woman being attacked by yellow fever and recovering without miscarriage, immunity from future attacks is conferred upon the offspring contained in the womb during the attack. This is an extremely interesting proposition. I regret that I have only three accurate observations which support it, but I believe that further investigations will confirm its truth.

5. "The recently-delivered woman is more liable to be attacked by yellow fever than one differently circumstanced, both being equally exposed. I cannot establish this proposition by any indisputable facts. It is a current belief among those who have observed much yellow fever that traumatic conditions invite attacks of yellow fever. My own observations support this opinion, and more especially as it relates to the parturient woman.

6. "The recently-delivered woman, being attacked by yellow fever, encounters an increased degree of danger nearly or quite equal to that of the pregnant woman."

*Cholera.*—Pregnant women evince neither proclivity to nor immunity from cholera. As in variola, the disposition to, and the mortality of, the disease increase with the duration of pregnancy. The prospect of recovery is especially unfavorable during the sixth and seventh months. Pregnancy is commonly interrupted when the woman survives the terribly rapid course of the disease. Many women die with the product of conception in the uterine cavity. Very exceptionally, in the milder forms of the disease recovery may occur without the interruption of gestation. The causes of abortion or premature labor consist in the constant hemorrhagic endometritis, and the death of the fœtus from asphyxia as the result of the changes in the pressure and constitution of the blood. The spasms of the abdominal muscles and diaphragm (Bouchut) play a subordinate rôle. Bühl, Gutterbock, and others are of the opinion that the infection is transmitted by the mother to the fœtus in utero.

*Syphilis.*—Syphilis,[1] acquired at the time of fruitful coitus or during the course of pregnancy, is characterized by the brief duration of the stage of incubation, the intensity of the initial lesions, and the mildness of the consecutive symptoms. The period of incubation is commonly two weeks, exceptionally six weeks. The initial lesion develops rapidly and extensively, not infrequently involving the vulva, vagina, vaginal portion, nates, and inner surfaces of the thighs. The symptoms are marked local reaction, reddening and excoriation of the obstacle to the distension of the bladder, vesical tenesmus, dysuria, incontinence, and constipation first attract the patient's attention to her condition. Cazeaux, Graily Hewitt, and others have emphasized the causal relation of uterine displacements in general, and of anteflexions in particular, to the pernicious vomiting of pregnancy. Incarceration and retention of urine seldom if ever occur in the absence of other morbid conditions, although the displacement behind the symphysis may persist in exceptional cases as late as the fifth month. Ahlfeld,[1] indeed, describes two cases of anteflexion of the pregnant uterus in which hemorrhages occurred, but the alarming symptoms ceased upon the assumption of the horizontal position. The anatomical relations of the pubic symphysis, the small expanse of the vesico-uterine ligament as compared with that of the cul-de-sac of Douglas, the alternate distension and evacuation of the bladder, and the posture of the woman in rest,—all tend to prevent incarceration. Commonly, the uterus ascends spontaneously into the abdominal cavity, and the symptoms referable to the bladder and rectum cease. Anteversions, and in particular anteflexions, alone or in connection with the concomitant endometritis, often sustain a causal relation to sterility, but very seldom lead directly or indirectly to abortion.

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[1] Sigmund: *Weiner med. Presse*, xiv., 1873, No. 1.

Manual reduction of the displacement, regulation of the functions of the bladder and rectum, rest in the dorsal decubitus, commonly fulfil all indications for treatment. It is seldom necessary to introduce a pessary, although the fact of pregnancy does not constitute a positive contraindication to the use of an appropriate instrument.

Toward the end of pregnancy a peculiar form of anteversion, usually associated with anteflexion, constituting the so-called pendulous abdomen, is liable to occur. This anomaly consists in an abnormal yielding of the anterior abdominal wall before the intra-abdominal tension and the weight of the gravid womb. In the higher degrees of the displacement a diastasis of the recti muscles is effected, and the pregnant womb, covered only by skin and fascia, protrudes to a variable extent through this space. Occasionally, the organ is dislocated to such a degree as to rest upon the thighs of the patient, constituting a true abdominal hernia. All conditions which tend to diminish the integrity and tonicity of the muscles of the anterior abdominal wall are predisposing factors. Accordingly, the deformity is observed more frequently among multigravidæ than primigravidæ. Cicatrices from operations or injuries often yield during the course of pregnancy and become the sites of eventration. Pelvic contraction, however, is the most important causal agent. The engagement of the presenting part and the fixation of the lower uterine segment are prevented, and uterus, relatively free in the abdominal cavity, is pushed forward the contractions of the diaphragm and the pressure of the intestinal mass. This effect is increased by lordosis of the lumbar vertebræ, diminishing the distance between the pubes and the ensiform cartilage and great inclination of the pelvis.

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[1] *Arch. f. Gyn.*, Bd. xiii. p. 161.

The SYMPTOMS are of a mechanical nature, and consist in pains in the stretched skin, excoriations in the cutaneous foldings, œdema of the lower portion of the abdominal surface, functional disorders in connection with the bladder and rectum, difficulty in locomotion. The higher degrees of pendulous abdomen are of considerable moment in the determination of oblique presentations of the fœtus.

The TREATMENT consists in the manual rectification of the anteversion, and the retention of the uterus in its normal position by means of a neatly-fitting binder. During labor the dorsal decubitus, elevation of the displaced organ, and retention in situ, especially during pains, until engagement of the presenting part and fixation of the lower uterine segment, commonly answer all therapeutic requirements. Operative interference is often indicated on account of the failure of the contraction of the abdominal parietes or by reason of pelvic deformities.

### RETROVERSION.

Retroversion is a relatively infrequent permanent displacement of the unimpregnated uterus. It is often, but by no means invariably, a cause of sterility; so that if the uterus is found retroverted in pregnancy the inference is not justifiable that an accident has probably occurred after the beginning of gestation. In the event of conception, spontaneous rectification commonly takes place before the end of the third or fourth month, or the retroversion is converted into a retroflexion as the result of the softening and other textural changes incident to pregnancy and the resistance opposed to the cervix. In many cases the axis of the cervix forms with the axis of the corpus a curved line with its concavity downward, and the uterus assumes the shape of a retort (Spiegelberg).

### RETROFLEXION.

Retroflexion of the unimpregnated uterus is one of the most frequent displacements in women who have borne children, but it is seldom the cause of acquired sterility. Out of 79 cases of retroversion of the gravid uterus, Charles[1] found that 13 occurred in primiparæ and 66 in multiparæ. On the other hand, this malposition is rare in women who have not borne children, but is a potent cause of barrenness.

While the normal position of the gravid womb is probably one of anteversion or mobile anteflexion, it must not be forgotten that intra-abdominal tension, throw an additional amount of work upon the left heart, to the performance of which it is entirely unequal. Accordingly, irregular heart-action and dyspnœa, followed sometimes by the interruption of pregnancy, less frequently by sudden death, ensue.

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[1] *Des déplacements de la matrice en arrière pendant la grossesse*, Paris, 1878.

After labor and the elimination of the placental circulation arterial tension is lowered, venous blood-pressure is elevated, and the right heart is menaced. In mitral insufficiency and dilatation of the left ventricle, without compensatory hypertrophy of the right heart, the effect of these sudden variations in blood-pressure is especially grave. Dyspnœa, pulmonary œdema, general anasarca, albuminuria, ascites, pleural effusions, are among the symptoms occasionally observed. Fritsch[1] is of the opinion that these phenomena are very frequently due to the sinking of intra-abdominal pressure, the accumulation of blood in the great abdominal vessels, and cardiac paralysis from insufficient blood-supply.

During labor, one of the chief sources of danger in all valvular defects consists in pulmonary œdema.

Löhlein and Kleinwachter[2] believe that the great danger from chronic heart disease with valvular defects occurs during the puerperium, and lies in the tendency to the recurrence of the original endocarditis.

The increased dangers of chronic valvular disease, directly or indirectly traceable to pregnancy, are so numerous, serious, and inevitable that marriage and maternity ought not to be permitted before the individual in the concrete case is clearly informed of the risks entailed.

TREATMENT.—The general therapy of chronic heart disease is not different from the treatment in the non-gravid state. The induction of premature labor may become necessary, but the nature and limitations of this indication must be considered in another article. During labor early recourse to the forceps or version and extraction is indicated in the interest both of the mother and the child.

### PULMONARY TUBERCULOSIS.

Contrary to the formerly received opinion, it is now a well-established fact that pregnancy exercises, as a rule, a distinctly unfavorable influence on hereditary or acquired pulmonary tuberculosis. Latent tendencies to the disease are developed and the progress of the existing affection is hastened. These effects upon the course of phthisis are observed most frequently between the ages of twenty and thirty years, although of not rare occurrence between thirty and forty. To these generalizations there are occasional exceptions. The disease is sometimes, very rarely, observed to make no progress during gestation, and the patient may decidedly improve during the lying-in period. The puerperal phases, as remarked by Spiegelberg, exercise such varied influences upon the development and course of tuberculosis that it is an imperative necessity to individualize in every case.

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[1] *Arch. f. Gyn.*, Bd. viii. p. 373; *Ibid.*, Bd. x. p. 270.

[2] *Grundriss d. Geburtshülfe*, 1881, p. 190.

When the disease progresses during pregnancy abortion or premature labor may take place or the woman may die undelivered. Infants born of tuberculous women are usually weak and sickly, and frequently perish during the first months of life. For these reasons it is an established rule of practice to inform women of the tuberculous diathesis of the danger entailed by the marital relation. The infection of the husband is observed with sufficient frequency to constitute a formidable objection to marriage. A woman affected with tuberculosis ought never to suckle her child. As a rule, however, there is seldom any necessity for such a warning, as the function of lactation is rarely established in tuberculous women.

## DISPLACEMENTS OF THE GRAVID WOMB.

### ANTEFLEXIONS AND ANTEVERSIONS.

During the early months of pregnancy the normal anteversion or mobile anteflexion of the uterus is increased, and certain functional disturbances in connection with the bladder and rectum often arise from mechanical pressure.

Pathological anteversions of the pregnant uterus while that organ is contained within the pelvic cavity are of extremely rare occurrence. In the absence of pelvic tumors, exudates, or antecedent anterior displacement they are commonly conditioned upon a large pelvis with relatively great conjugate diameters (Ahlfeld), retraction of the utero-sacral ligaments, and unusual development of the anterior uterine wall, aided by the intra-abdominal pressure applied over the posterior wall. Under the expression "inclination of the pelvic canal" Kiwisch designates the angle which the plane of the inlet forms with the posterior surface of the pubic symphysis. Normally, this angle measures about one hundred degrees. When the symphysis tends to assume a vertical direction, this angle becomes more obtuse, and a condition favoring anteversion and incarceration is presented. Tarnier[1] describes "a sort of tension, or even of contracture, which involves the vaginal vault and broad ligaments, so that the uterus is absolutely immobilized in its vicious direction." Very rarely the anterior dislocation of the pregnant womb may be acute, the result of traumatism, as in the cases cited by Moreau and Hüter. Morbid, immobile anteflexions of the pregnant uterus are almost invariably examples of the persistence of a pathological state acquired before conception.

SYMPTOMS.—Frequent urination on account of the mechanical obstacle to the distension of the bladder, vesical tenesmus, dysuria, incontinence, and constipation first attract the patient's attention to her condition. Cazeaux, Graily Hewitt, and others have emphasized the causal relation of uterine displacements in general, and of anteflexions in particular, to the pernicious vomiting of pregnancy. Incarceration and retention of urine seldom if ever occur in the absence of other morbid conditions, although the displacement behind the symphysis may persist in exceptional cases as late as the fifth month. Ahlfeld,[1] indeed, describes two cases of anteflexion of the pregnant uterus in which hemorrhages occurred, but the alarming symptoms ceased upon the assumption of the horizontal position. The anatomical relations of the pubic symphysis, the small expanse of the vesico-uterine ligament as compared with that of the cul-de-sac of Douglas, the alternate distension and evacuation of the bladder, and the posture of the woman in rest,—all tend to prevent incarceration. Commonly, the uterus ascends spontaneously into the abdominal cavity, and the symptoms referable to the bladder and rectum cease. Anteversions, and in particular anteflexions, alone or in connection with the concomitant endometritis, often sustain a causal relation to sterility, but very seldom lead directly or indirectly to abortion.

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[1] Tarnier et Budin: *Pathologie de la Grossesse*, Paris, 1886, p. 60.

Manual reduction of the displacement, regulation of the functions of the bladder and rectum, rest in the dorsal decubitus, commonly fulfil all indications for treatment. It is seldom necessary to introduce a pessary, although the fact of pregnancy does not constitute a positive contraindication to the use of an appropriate instrument.

Toward the end of pregnancy a peculiar form of anteversion, usually associated with anteflexion, constituting the so-called pendulous abdomen, is liable to occur. This anomaly consists in an abnormal yielding of the anterior abdominal wall before the intra-abdominal tension and the weight of the gravid womb. In the higher degrees of the displacement a diastasis of the recti muscles is effected, and the pregnant womb, covered only by skin and fascia, protrudes to a variable extent through this space. Occasionally, the organ is dislocated to such a degree as to rest upon the thighs of the patient, constituting a true abdominal hernia. All conditions which tend to diminish the integrity and tonicity of the muscles of the anterior abdominal wall are predisposing factors. Accordingly, the deformity is observed more frequently among multigravidæ than primigravidæ. Cicatrices from operations or injuries often yield during the course of pregnancy and become the sites of eventration. Pelvic contraction, however, is the most important causal agent. The engagement of the presenting part and the fixation of the lower uterine segment are prevented, and the uterus, relatively free in the abdominal cavity, is pushed forward by the contractions of the diaphragm and the pressure of the intestinal mass. This effect is increased by lordosis of the lumbar vertebræ, diminishing the distance between the pubes and the ensiform cartilage and great inclination of the pelvis.

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[1] *Arch. f. Gyn.*, Bd. xiii. p. 161.

The SYMPTOMS are of a mechanical nature, and consist in pains in the stretched skin, excoriations in the cutaneous foldings, œdema of the lower portion of the abdominal surface, functional disorders in connection with the bladder and rectum, difficulty in locomotion. The higher degrees of pendulous abdomen are of considerable moment in the determination of oblique presentations of the fœtus.

The TREATMENT consists in the manual rectification of the anteversion, and the retention of the uterus in its normal position by means of a neatly-fitting binder. During labor the dorsal decubitus, elevation of the displaced organ, and retention in situ, especially during pains, until engagement of the presenting part and fixation of the lower uterine segment, commonly answer all therapeutic requirements. Operative interference is often indicated on account of the failure of the contraction of the abdominal parietes or by reason of pelvic deformities.

### RETROVERSION.

Retroversion is a relatively infrequent permanent displacement of the unimpregnated uterus. It is often, but by no means invariably, a cause of sterility; so that if the uterus is found retroverted in pregnancy the inference is not justifiable that an accident has probably occurred after the beginning of gestation. In the event of conception, spontaneous rectification commonly takes place before the end of the third or fourth month, or the retroversion is converted into a retroflexion as the result of the softening and other textural changes incident to pregnancy and the resistance opposed to the cervix. In many cases the axis of the cervix forms with the axis of the corpus a curved line with its concavity downward, and the uterus assumes the shape of a retort (Spiegelberg).

### RETROFLEXION.

Retroflexion of the unimpregnated uterus is one of the most frequent displacements in women who have borne children, but it is seldom the cause of acquired sterility. Out of 79 cases of retroversion of the gravid uterus, Charles[1] found that 13 occurred in primiparæ and 66 in multiparæ. On the other hand, this malposition is rare in women who have not borne children, but is a potent cause of barrenness.

While the normal position of the gravid womb is probably one of anteversion or mobile anteflexion, it must not be forgotten that

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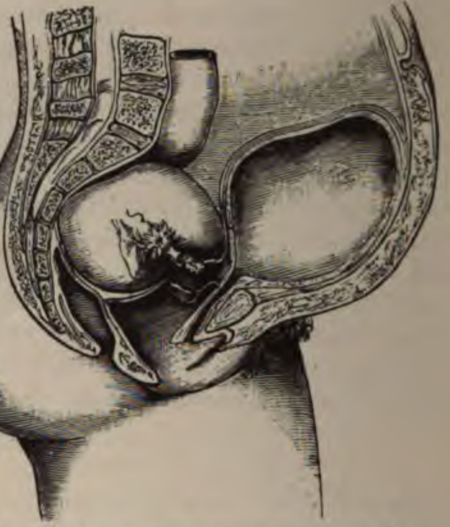
[1] *Des déplacements de la matrice en arrière pendant la grossesse*, Paris, 1878.

Braune's frozen section of a finely-formed primipara, with firm tissues and strong muscles, in the eighth week of pregnancy (see Fig. 210), shows the "body of the uterus sharply bent against its neck and

FIG. 209.



Retroflexion of the Gravid Uterus, schematic (Schultze).

turned backward." The texture of the uterus was absolutely normal, and Braune expresses the view that this was the position of the organ before death.

CAUSES.—Tyler Smith[1] has shown that retroflexion of the gravid uterus presupposes a retroflexion of the unimpregnated organ in the very large majority of cases. At the same time, it cannot be denied that sudden and considerable increase in intra-abdominal pressure, as in severe vomiting or after a fall, may constitute a cause adequate to the acute retroversion of an organ already slightly prolapsed and in a position of reclination. The distended bladder, an important adjuvant under these conditions, is never in itself sufficient to the production of such a displacement.

SYMPTOMS, COURSE, AND TERMINATIONS.—According to the cause of the displacement, symptoms are commonly developed gradually, and only in exceptional cases suddenly. As the uterus increases in size the functional disturbances in connection with the bladder and rectum, so frequently present during the first three months of pregnancy, are augmented. The woman complains of a sensation of weight and fulness in the pelvis, of pains, paroxysmal or constant, radiating along the nerve-trunks of the sacral and lumbar plexuses, of bearing-dow

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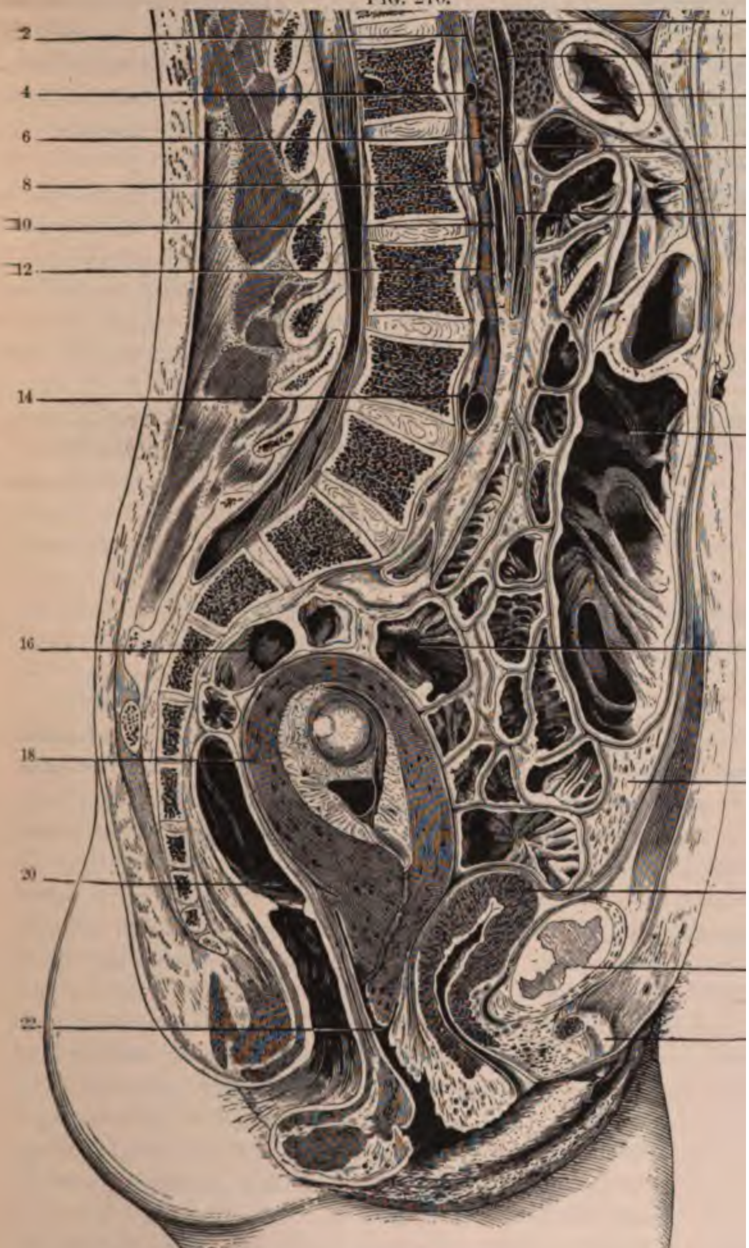
[1] *Obstetrical Transactions*, vol. ii.

Fig. 210.



Plane Frozen Section of a Finely-formed Primipara in the Eighth Week of Pregnancy (
1, pancreas; 2, left renal vein; 3, splenic vein; 4, right renal artery; 5, stomach;
pancreas; 7, superior mesenteric vein; 8, right internal spermatic artery; 9, superio
teric artery; 10, duodenum; 11, transverse colon; 12, abdominal aorta; 13, iliac fle
left common iliac vein; 15, major omentum; 16, rectum; 17, urinary bladder; 18,
19, symphysis pubis; 20, rectum; 21, clitoris; 22, vagina.

efforts, of unusual difficulty in locomotion. Various reflex phenomena, of which vomiting is especially noteworthy, are often present.

Intense pain, referred to the hypogastric and pelvic regions, a variable degree of shock, retention of urine, vomiting, and sudden inability to walk commonly mark the occurrence of the very rare accident of acute retroversion or retroflexion.

Bimanual examination reveals the cervix elevated behind or above the symphysis, while the smooth, round tumor of characteristic consistence, corresponding to the corpus, occupies the cul-de-sac of Douglas. The anterior vaginal fornix is empty, and the hypogastric region free from any circumscribed enlargement after the catheterization of the bladder. The catheter shows this organ displaced downward and backward.

Retroflexion of the gravid uterus ends in spontaneous rectification, abortion, incomplete rectification, or the organ becomes incarcerated.

*Spontaneous Rectification.*—In the majority of cases the uterus continues to grow in size until the pelvic cavity is no longer able to contain it, when the fundus elevates itself and passes up over the promontory in the direction of least resistance, and the backward displacement is substituted within a few days by the normal anteversion or anteflexion. Doubtless, in this spontaneous elevation the fundus is aided, as Spiegelberg says, by the musculature of the round and broad ligaments. This change commonly occurs without the consciousness of the patient. Spontaneous cure may result in this manner, even though extensive peritoneal adhesions and exudates into the pelvic connective tissue are present. These morbid products frequently undergo a kind of evolution analogous to that in the tissues of the genitalia, yielding and stretching before the growing womb.

In certain cases the process of spontaneous rectification is extraordinarily protracted. The anterior uterine wall grows upward into the pelvis major until larger and larger portions of the uterus and fœtus are contained within the abdominal cavity. Finally, the over-weight of the abdominal mass lifts the remainder of the uterus and fœtus out of the pelvic cavity. It is not possible to fix with certainty the ultimate limit in point of time at which spontaneous reduction may take place, especially if the process is protracted. As a rule in practice, however, it may be assumed that if the organ has evinced no tendency to elevation before the end of the third month, one of the other terminations will ensue.

*Abortion.*—Abortion ranks only second in frequency among the terminations of retroflexion of the gravid uterus. In habitual abortion before the third month retro-displacements constitute a very common and important cause. The factors immediately concerned in this accident are the complicating metritis—predisposing to expulsive contractions—and endometritis, and the hyperæmia and hemorrhages into the decidua consequent upon the venous stasis from the retroflexion. The mechanical hindrance to the growth of the uterus opposed by the pelvis is of much less causal moment. Spiegelberg has made the interesting observation that during the expulsion of the ovum the retroflexion is diminished to a reclination, and that the uterus remains in this position for a short time after its evacuation—a fact which demonstrates the adjuvant effect of the musculature of the round and broad ligaments, as well as of the womb, in the act of spontaneous rectification. The separation and expulsion of the ovum, together with the superficial layers of the decidua, under these conditions is usually complete, and the termination is justly considered favorable. However, the danger of retention of portions of the fœtal envelopes and of imperfect drainage is considerably greater than when the uterus occupies its normal position. Extraordinary care is accordingly indicated in the thorough evacuation and permanent disinfection of the cavum uteri.

*Incomplete Retroflexion.*—In very rare cases the process of spontaneous rectification is incomplete, and that portion of the uterus which fills out the pelvic cavity persists in situ. This condition is variously known as partial retroflexion or retroflexion in the second half of pregnancy. The cervix is found close behind or above the symphysis, the postero-inferior portion of the uterus is wedged into the cul-de-sac of Douglas, between the cervix and the promontory, by the presenting part, usually the head, while the greater portion of the uterus and of the fœtus is contained within the abdominal cavity above the inlet.

FIG. 211.

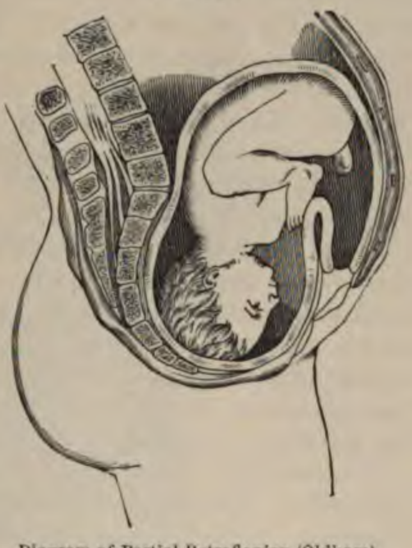


Diagram of Partial Retroflexion (Oldham).

A perfectly distinct morbid state of the uterus which closely simulates in certain symptoms partial retroflexion is occasionally observed during the last two months of pregnancy, and has received from Wigand the appellation of sacciform dilatation of the posterior uterine wall. Scanzoni[1] regards this condition as an error of form rather than as a displacement, and as caused by the descent of the postero-inferior portion of the lower uterine segment into the fossa of Douglas under

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[1] *Lehrb. d. Geburtshülfe*, Bd. ii. p. 38, 1867.

the pressure of the presenting part. It is observed, according to this author, especially in cases of pendulous abdomen when the inclination of the pelvis is relatively slight. The over-weight of the child's pelvis and trunk, protruding forward beyond the normal plane, directs the head toward the hollow of the sacrum, and drives the relaxed uterine parenchyma downward and backward before the presenting part. Depaul[1] refers sacciform dilatation of the posterior uterine wall to certain morbid states acquired before or during pregnancy, of which flexions in general and anteflexions in particular are the more important. The posterior uterine wall undergoes a higher degree of evolution than the anterior, because its tissues are more nearly normal and because it is more distended. Little by little, the postero-inferior portion of the lower uterine segment descends into the pelvic cavity, while the anterior wall and the neck are elevated. The condition here outlined is not hypothetical. Apart from the actual observation and clear description of examples of the anomaly by Mende, Kiwisch, Scanzoni, Frank, Wigand, Chailly, Hyernaux, and others, its analogue has been seen in the anterior uterine wall. Thus, Spiegelberg[2] clearly points out the clinical features of sacciform dilatation of the anterior wall of the lower uterine segment.

While the symptoms of posterior obliquity or sacciform dilatation of the posterior uterine wall are, as a rule, relatively insignificant (Scanzoni), partial retroflexion is frequently attended by an exaggeration of all the pressure-disturbances which are observed in cases of posterior displacements during the first three months. In particular, there is grave danger of compression of the ureters and consequent disease of the kidneys, as illustrated in a case reported by Robert Barnes.[3]

The course and terminations of partial retroflexion of the gravid uterus are various. Spontaneous rectification late in pregnancy is occasionally observed. Abortion or premature labor is of more frequent occurrence. Out of 11 cases collected by Veit,[4] pregnancy was prematurely interrupted in 5. Symptoms of incarceration are liable to appear at any time. Finally, pregnancy may continue until term. In 5 of the cases collected by Veit labor took place at the expiration of the full period of utero-gestation. W. S. Stewart[5] has recently reported an interesting case of pregnancy in a partially retroflexed uterus continuing until term, and ending favorably both to mother and child.

During labor grave complications commonly arise, since the axis of the cervix, displaced upward and forward behind or above the symphysis, does not coincide with the axis of the parturient canal, and the presenting part, under the influence of uterine contractions, drives the

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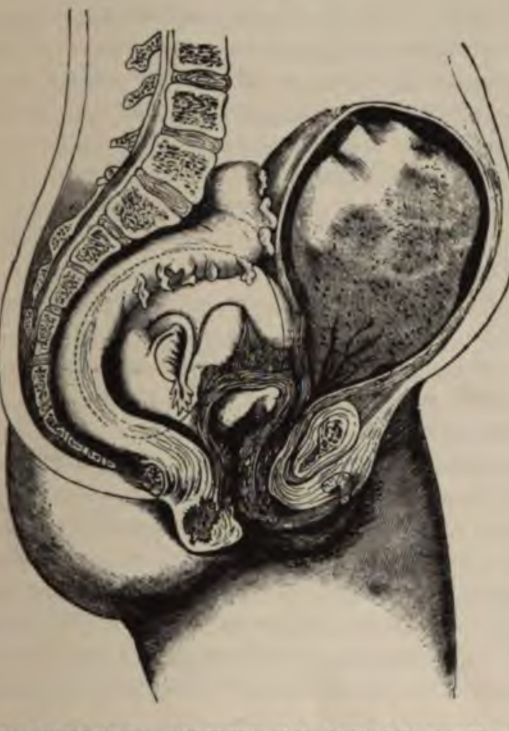
[1] *Arch. Tocol.*, 1876. [2] *Loc. cit.*, p. 265. [3] *Loc. cit.*, p. 262.

[4] *Volkmann's Sammlung klin. Vortr.*, 1879, No. 170.

[5] *Trans. Ninth International Medical Congress*, 1887.

posterior diverticulum downward against the pelvic floor and perineum. Even at this time spontaneous elevation of the pouch occupying the pelvic cavity may occur under powerful labor-pains prolonged through a considerable period of time and the normal retraction of the lower uterine segment. In other cases the postero-inferior segment of the uterus may be ruptured, or labor comes to a standstill with the usual fatal consequences unless timely assistance is rendered. The attachment of the placenta to the portion of the uterine parenchyma contained within the pelvis is an additional source of danger; the organ usually requires manual extraction (Credé).

FIG. 212.



Retroflexion of the Gravid Uterus—Exfoliation of the Vesical Mucous Membrane (Schatz).

DIAGNOSIS.—The recognition of partial retroflexion and sacciform dilatation of the posterior uterine wall commonly involves no especial difficulty when the half hand is introduced into the vagina. Conglutination[1] of the external os may in exceptional cases closely simulate the conditions under consideration. However, the cervix can always be discovered in partial retroflexion after a careful search; and this finding is sufficient to clear up all obscurity in diagnosis.

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[1] Depaul committed this error in diagnosis (Obs. II.). He was unable to find the os uteri in a case of labor, and made an incision through what subsequently proved to be the postero-inferior uterine segment. The patient died with the fœtus in utero.

It is never easy, and frequently impossible, to distinguish between partial retroflexion and sacciform dilatation of the posterior uterine wall during pregnancy and labor. The history of the case yields the most important data. When the uterus is evacuated direct examination of the posterior uterine wall discloses the true nature of the state. So far as treatment is concerned, this information is of comparatively slight moment.

TREATMENT.—During pregnancy the treatment is expectant, and consists in the alleviation of the vesical symptoms and obstinate constipation. The systematic employment of the genu-pectoral posture, together with gentle manipulation per vaginam and per rectum, according to the indications in the concrete case, aids in the process of spontaneous restitution. During labor these efforts at taxis may be more energetic, the half hand being introduced into the rectum in the attempt to elevate the posterior diverticulum, while the other hand, applied to the abdomen above the pubes, displaces the cervix and anterior portion of the lower uterine segment downward. In the cases of Oldham[1] and Stillé[2] delivery was effected by podalic version after digital dilatation of the cervix. Robert Barnes in a similar case was enabled to push the pelvic mass upward into the cavity of the abdomen when the cervix was dilated by water-bags, and the delivery of a living child effected by the forceps. The ultimate resource is vaginal hysterotomy, with extraction of the child through the incision.

*Incarceration.*—When the retroflexion does not terminate in one of the three modes just described, symptoms of incarceration follow. Provided that the original position of the uterus and the pelvic dimensions are normal, it is doubtful, as before remarked, whether any acute cause, such as a fall, is ever sufficient to effect a posterior displacement at a time when the organ is large enough to produce at once symptoms of incarceration. The persistence of complete retroflexion and the occurrence of incarceration must be regarded as exceptional events, while termination in spontaneous rectification, abortion, or partial restitution is the more usual course.

SYMPTOMS, COURSE, AND TERMINATIONS.—In harmony with the usual mode of origin, the symptoms of incarceration are commonly developed gradually, and are preceded by the mechanical disturbances of the functions of the bladder and rectum already mentioned. Sometimes, however, these disorders are relatively slight, and fail to attract the patient's attention, so that the signs of incarceration are apparently developed suddenly.

Probably the first symptom of the condition consists in the so-called ischuria paradoxa, the incontinence of retention. The lumen of the urethra is more or less completely obstructed by the stretching of the canal in the direction of its long axis and the pressure of the cervix against the symphysis. Painful paroxysmal contractions of the distended bladder occur, and a small quantity of urine, sufficient to diminish intravesical tension, is voided. The patient complains of vesical tenesmus and incontinence, while the bladder, full to bursting, is palpable as a tumor above the pubes, varying in size from a child's head to the uterus at term. Defecation is difficult and painful. Later, there is retention not only of scybala, but also of gases, so that tympanites is developed. Vomiting, even of stercoraceous matter, fever, and all the symptoms of ileus make their appearance. Agonizing pain, referred to the sacral, lumbar, and hypogastric regions and radiating along the trunks of the sacral and lumbar plexuses, is constant. At first, it is due to pressure, but later to active inflammatory changes. The mechanical varices and œdema of the vulvar, anal, and perineal regions and the lower extremities become greatly exaggerated, while locomotion is usually rendered impossible.

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[1] *Obstet. Trans.*, vol. i. p. 31.

[2] *Memorabil.*, 1881.

Occasionally, even after incarceration, spontaneous restitution, complete or incomplete, takes place. More frequently, uterine contractions are excited and the ovum is expelled. Abortion under these conditions is apt to be incomplete, and the removal of the remainder of the fœtal envelopes is frequently indicated. In either event, recovery ensues, provided the uterine parenchyma, the bladder, the rectum, and the adjacent pelvic peritoneum and connective tissue have not already sustained irreparable injury. When these natural terminations do not take place, and when aid is not rendered, death is inevitable. A fatal issue, however, is extremely rare; it may result from a variety of causes.

In exceptional cases, under the vesical and rectal tenesmus and the violent involuntary bearing-down efforts, the womb, pressed downward against the pelvic floor, bulges the posterior wall of the vagina forward until the tissues give way and the organ appears at the vulvar orifice,[1] or the anterior wall of the rectum may be inverted and the uterus present through the anus.[2]

But the sequelæ of urinary retention are of most frequent occurrence and of gravest prognostic moment. If retention is effected slowly, the muscular walls of the bladder undergo a considerable hypertrophy. As the intravesical tension increases the walls of the bladder are thinned out and the blood-supply is limited, so that nutritive disturbances in the mucosa take place. At the same time, the urine undergoes ammoniacal decomposition, with the production of cystitis, which soon is transformed into diphtheritic inflammation. Partial or complete rupture of the bladder follows under the constantly increasing tension. The usual course is rupture of the mucosa with urinary infiltration of the muscularis.[1] Gradually, the entire mucous membrane may be detached, and either pass out in shreds through the urethra or remain as a free cast within the bladder. Sometimes, after reposition of the uterus, a partial necrosis of the bladder and its peritoneal covering is observed after a somewhat different mechanism. The organ does not contract and its walls fall together, so that the fundus is partially inverted. Peritoneal adhesions form over the inverted portion, which is subsequently sloughed off. Examples of this condition have been described by Frankenhäuser[2] and Madurowicz.[3] Destruction of part or all of the vesical mucosa, and even of the fundus, however, is not necessarily fatal.[4] Complete rupture, involving the entire vesical wall, is sometimes observed. Acute rupture may follow, though rarely, trauma, as unskilful catheterization (Ahlfeld) or a fall (Martin). Under these conditions the decomposed urine is apt to escape into the abdominal cavity, with rapidly fatal issue. Commonly, adhesions have formed before perforation of the peritoneum, and the urine is encapsulated, ultimately making its exit, when not absorbed, through intestinal fistulæ (Schroeder), or infiltrating the pelvic connective tissue.

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[1] Grenser, *M. f. G.*, Bd. ix. p. 73; Mayer: *Presse Med.*, Bd. i., 1837, p. 153.

[2] Halbertsma: *M. f. G.*, Bd. xxxiv. p. 415.

Retrostasis of urine along the ureters induces, with relative frequency, dilatation of these canals, pyelitis, pyelo-nephritis, hydro-nephrosis, and the like. Urinæmia was the chief cause of death in four cases observed by Robert Barnes.[5] Carl Braun[6] has recorded one case in which death followed eclampsia—symptomatic of urinæmia—and perforation of the bladder.

General peritonitis is of rare occurrence except as a symptom of septicæmia or after perforation of the bladder. The tympanites from obstipation and the pain upon pressure over the distended bladder and incarcerated uterus, as remarked by Spiegelberg, may simulate this condition. Pericystitis, perimetritis, and periproctitis are observed more frequently, although in the case described by Schatz, notwithstanding the duration of the incarceration through one month and the necrosis of the vesical mucosa, no adhesions were present in the pelvic peritoneum. In five fatal cases observed by Robert Barnes no peritonitis was noted. Acute metritis, involving the pelvic connective tissue and perimetrium, may be the starting-point of general septi infection. Septicæmia more commonly results from the resorption of pus from the bladder. Finally, death may occur from exhaustion and ileus.[1]

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[1] Schatz: *Arch. f. Gyn.*, Bd. i. p. 460; Krukenberg: *Ibid.*, Bd. xix. p. 261; Zweife *loc. cit.*, p. 307; Kleim: *Inaug. Dissert.*, Berlin, 1880.

[2] *Arch. f. Gyn.*, Bd. xii. p. 352.

[3] *Wien. med. Wochenschr.*, 1877, Nos. 51 and 52.

[4] Schwarz: *Centralb. f. Gyn.*, No. 6, 1880.

[5] *Loc. cit.*, p. 2[illegible]3

[6] *Loc. cit.*, p. 294.

DIAGNOSIS.—The diagnosis is commonly simple when the fact of pregnancy is established. The distended bladder, behaving as a tumor of the abdominal walls,[2] presents on inspection and palpation characteristic appearances as regards size, form, consistence, and mobility. Fluctuation is distinct unless the intravesical tension is exceptionally great. Zweifel[3] is responsible for the assertion that dribbling of urine in a woman pregnant at the third or fourth month is a certain sign of incarceration. While such a universal proposition is an inaccurate statement, since other morbid states may cause the same phenomenon, still, the symptom always indicates a careful bimanual exploration of the pelvic viscera. In the majority of cases the dribbling of urine will be found to be an example of the incontinence of retention produced by the incarceration of the retroflexed uterus. After catheterization, bimanual exploration reveals the presence of a tumor corresponding in size, form, and consistence to the retroflexed uterus within the pelvic cavity and the absence of such a body in the hypogastric region. Anæsthesia is often necessary to such an examination, on account of meteorism, abdominal and pelvic tenderness. The presence of a tumor corresponding to the uterus within the pelvic cavity, and the absence of such a tumor from the hypogastrium, exclude at once incarcerated fibroids, ovarian cysts, hæmatocele, and hæmatoma. Kidd[4] records a case of intra-uterine polyp which simulated retroflexion of the pregnant womb with incarceration, but the symptomatic menorrhagia was sufficient to differentiate between the two conditions.

Ectopic pregnancy in the cul-de-sac of Douglas resembles in its clinical course the condition under notice. Bailly[5] describes the interesting case of a woman, pregnant three months and a half, with symptoms of urinary retention and obstinate constipation. After the evacuation of the contents of the bladder two tumors were discoverable, one above the pubes, one intrapelvic. The sound introduced into the uterus passed a distance of 8 cm. in the direction of the suprapubic tumor, and the diagnosis of extra-uterine pregnancy posterior to the uterus was made. The supposed retro-uterine tumor gradually disappeared, and the fact of partial retroflexion of the uterus was fully recognized before abortion demonstrated the intra-uterine nature of the pregnancy, or the autopsy the exact anatomical relations. It is highly probable that many of the cases of alleged incarceration[6] and sloughing of the uterine parietes, with the slow discharge of the ovum through fistulous channels into the rectum, vagina, and bladder, are in reality examples of ectopic gestation. The differential diagnosis under these conditions becomes very perplexing. But the history of the case furnishes data of moment. Then in ectopic gestation in the cul-de-sac of Douglas careful observation through a sufficient period of time will disclose the presence of two distinct and more or less separate tumors, the one behind the symphysis possessing the physical characters of the uterus, the other giving the signs of a growing elastic cyst containing bodies of greater resistance. Finally, the skilful use of the sound demonstrates the cavity of the uterus to be empty. While it is sometimes impossible to make a positive diagnosis between the two conditions, an opinion, supported by the weight of probable evidence and sufficient to act upon, may always be formed.

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[1] Hausmann: *M. f. G.*, Bd. xxxi. p. 132.

[2] Schroeder: *loc. cit.*, p. 393.

[3] *Loc. cit.*, p. 306.

[4] *Dublin Journ. Med. Sci.*, Nov., 1875, p. 457.

[5] *Arch. de Tocologie*, 1874, p. 731.

[6] Arthur Farre: *Cyclopædia of Anatomy;* Guichard: *Gaz. méd. de Paris*, 1856.

Treatment.—In view of the frequency of abortion and the gravity of incarceration, treatment having for its objective point the spontaneous elevation of the womb is urgently indicated in every case of pregnancy in a retroverted or retroflexed uterus. Prophylaxis under these conditions consists in the regular evacuation of the bladder and rectum, the avoidance of all muscular exertion capable of considerably increasing intra-abdominal tension, and the systematic employment of the genu-pectoral position. As pointed out by Spiegelberg, mild laxatives rather than enemata are indicated, since the tenesmus following the latter is apt to increase the backward displacement. When the uterus shows no tendency to spontaneous elevation before the end of the third month, as already remarked, active interference must be instituted and reduction effected by manipulation, usually aided by anæsthesia. Artificial reposition may be urgently indicated much earlier, notably in cases of threatened or habitual abortion.

In the event of incarceration the first duty of the physician is to direct attention to the bladder and secure its evacuation by catheterization. A flexible instrument of large calibre is preferable even to a metallic male catheter. The introduction of the instrument is often attended with difficulty on account of the long-drawn-out, tortuous course of the displaced urethra, and because the point of occlusion may be high up with a sacciform dilatation below, in which the tip of the catheter becomes lost. The immediate compression of the urethra ma be considerably diminished by pressing the cervix backward and a from the symphysis, and by the assumption of the knee-elbow post But, as before remarked, the mechanical interference with the flow urine is conditioned not so much upon compression of the urethra the cervix as upon the traction of the tube in the direction of its len The operation with sufficient skill and patience is practicable in al every case. Veit[1] in a remarkable experience of from 70 to 80 cases was invariably successful.

After the catheter has entered the bladder its aperture may be occluded by a bit of necrotic mucous membrane or a blood-clot. A stream of tepid water injected through the instrument will dislodge the fragment. Inasmuch as the vesical walls are frequently in a semi-paralytic state, it is well to draw off the urine gradually or at intervals, to permit the musculature to accommodate itself to the lessened tension. In the rarely exceptional cases in which catheterization is impracticable an attempt at reposition of the uterus may be made without the evacuation of the bladder. Failing in this manœuvre, aspiration is the only resource. The point of puncture should be in the median line about 8 cm. above the pubes, so that it may remain coincident with the perforation of the bladder and still be above the occlusion (Spiegelberg). Following the evacuation of the bladder E. Martin[2] observed the occurrence of spontaneous reposition in 4 out of 16 cases; in 11 replacement was effected in the genu-pectoral posture.

The second indication is the reposition of the uterus. To accomplish this purpose there is a variety of methods, manual and instrumental. Taxis per rectum or per vaginam, or both, in the knee-chest position, is the mode of election when the tenderness is not so great as to require at once anæsthesia. In the latter event the lithotomy posture is substituted. Two fingers, or even the half hand if small, may be introduced into the lower portion of the rectum, and pressure applied to the fundus, not immediately upward, but in the direction of one or other of the sacro-iliac joints, while the fingers of the other hand seek to bring the cervix downward and backward. The insertion of traction-forceps in the vaginal portion to effect the latter object is of doubtful propriety under all conditions, and is very seldom really necessary. Little by little, under patient, persistent, but gentle manipulation at one or more sittings, elevation of the fundus is secured unless the obstacle to replacement is absolutely insurmountable. Reposition is complete only when the fundus falls forward above the plane of the inlet and the vaginal portion is found near the hollow of the sacrum. After reduction a return of the former condition is prevented by rest in bed in the latero-prone position until the uterus is of sufficient size to maintain its position within the abdominal cavity.

The various instrumental methods employed from time to time with varying degrees of success possess at the present a largely historical interest, since taxis is capable of accomplishing more in a shorter period of time with less trauma. Playfair succeeded in the reduction of the displacement in two cases within twenty-four hours by the use of the continuous elastic pressure furnished by a pyriform india-rubber bag distended with water. Robert Barnes recommends the introduction into the rectum of his hydrostatic dilator. Levers of various forms—the spatula-lever of Antoine Petit, a single blade of the obstetrical forceps, the vectis—have been inserted into the rectum with the object of aiding the ascent of the uterus by the provision of an inclined plane.

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[1] *Volkmann's Sammlung klin. Vortr.*, No. 170, p. 1363.

[2] *Zeitschr. f. Geb. und Frauenkrank.*, Bd. i. p. 1.

It is necessary to recognize the fact that the retroflexion may be irreplaceable, and never to force reduction. The uterus may be immobilized by adhesions in the fossa of Douglas, or covered with the exudates of former pelviperitonitides, or retained by inflammatory swelling of the parts contained in the pelvis. Undue violence may rupture these adhesions or inflict fatal injury upon the uterus.[1]

When efforts at reposition have failed to release the uterus, the immediate induction of abortion is indicated. But this operation is commonly difficult, on account of the position of the cervix. However, the chief objection to the insertion of forceps in the vaginal portion is now removed, and the mouth of the uterus may frequently be exposed and rendered accessible by traction downward with a tenaculum. When practicable, a flexible bougie should be introduced between the chorion and decidua and permitted to remain. P. Müller[2] has suggested and practised, in a single case, the ingenious device of introducing the cut-off end of a male catheter, bent into a hook, through the cervical canal. A piece of catgut was then passed through this canula between the membranes and the uterine walls. Abortion occurred within twelve hours. The objection, only a relative one, to puncture of the membranes over the internal os is the danger of incomplete abortion.

When for any reason the induction of abortion after the modes just described is not possible, puncture of the uterus and aspiration of the ovum must be tried. The point of puncture should be the most prominent portion of the corpus as felt per vaginam. The objection to puncture of the fundus per rectum consists in the exposure to septic infection. Under antiseptic precautions, and when the needle passes perpendicular to the uterine wall, the danger from this operation is minimal. The puncture is soon closed by uterine contractions after the evacuation of the liquor amnii. Abortion, however, is apt to be incomplete. After the diminution in volume of the uterus by the induction of abortion reposition is usually practicable, when the uterine cavity may be completely emptied and disinfected.

Until within a very recent period the artificial induction of abortion has been the *dernier ressort* in the class of cases now under consideration. A few months since Olshausen[1] successfully extirpated the retroflexed uterus, pregnant in the third month, after failure in reposition and the induction of abortion, in a case of osteomalacic pelvis. Aspiration of the ovum through the vagina with Potain's apparatus, after two trials, having proved of no avail in the excitation of uterine contractions, and symptoms of peritonitis beginning upon the third day afterward, two expedients were considered—vaginal section of the uterus with enucleation of the ovum, and total extirpation per vaginam. This case is the first recorded example of total extirpation of the pregnant uterus per vaginam for any cause other than carcinoma. No doubt can exist as to the adequacy of the indication. The operation itself was technically easy. As pointed out by Hofmeier, Benckiser, and others, the softening and relaxation of the uterine ligaments incident to pregnancy greatly facilitate manipulation.

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[1] Schatz, Moldenhauer, Blundell: *Arch. f. Gyn.*, Bd. vi.

[2] *Beitr. zur. Geburts.*, Bd. iii. p. 67.

## PROLAPSE.

Prolapse of the pregnant uterus presupposes, in the large majority of examples, conception in an organ that has already suffered this displacement.[2] In certain cases the sperma is injected directly into the uterine cavity. Acute prolapse is seldom observed, but may occur during the early months of pregnancy from the same causes which produce the displacement in the non-gravid organ—sudden elevation of intra-abdominal pressure, especially when the bladder is full, as in jumping, falling, and the like.

All degrees of the displacement have been seen and recorded. However, no authentic case of pregnancy in complete procidentia persisting until term is recorded in the literature of the subject. In Wimmer's[3] remarkable case the patient died at the end of the sixth month, when the fundus was found below the plane of the outlet. Many cases of alleged complete and incomplete prolapse are in reality examples of hypertrophy of the supra- or intravaginal portions of the cervix, with or without descent of the uterus.[4]

The COURSE and TERMINATIONS of the condition under notice closely resemble the natural history of retroversion. In simple prolapse, without version, spontaneous elevation commonly takes place, just as it does after the physiological descent of the uterus during the first two months. Only a slight prolapse of the vaginal walls remains to mark the former displacement. Abortion during the early months is less frequent than in retroversion; usually it follows acute prolapse, on account of the rapid circulatory disturbances, hemorrhage into the membranes, and death of the fœtus. When spontaneous elevation does not occur, incarceration follows. Commonly, however, in these cases there is also some degree of backward displacement. In very rare cases the organ in its further development descends below the plane of the outlet, when abortion often follows. In other cases, if spontaneous or artificial reduction is not effected, the termination is in death.

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[1] A. Benckiser: "Totalexstirpation des im dritten Monat graviden retroflektirten Uterus wegen Unmöglichkeit der Reposition bei osteomalacischem Becken; Heilung," *Centralb. f. Gyn.*, No. 51, 1887, p. 824.

[2] Spancken: *Arch. f. Gyn.*, Bd. xvii. p. 128.

[3] Tarnier: *loc. cit.*, p. 218.

[4] *Zeitschr. f. Geb. u. Gyn.*, Bd. ii. p. 240.

In the DIAGNOSIS it is necessary to differentiate sharply between simple prolapse and hypertrophic elongation of the cervix with or without descent of the uterus.

The suggestions already made in connection with the treatment of backward displacements apply with equal force to the condition under notice, necessary changes being made for the slight difference in direction of the displacement. Care must be taken in the use of hard-rubber pessaries for the purpose of retention. In many cases the presence of a foreign body of this nature in contact with the lower uterine segment is sufficient to determine expulsive contractions of the uterus. Rest, posture, and the cotton-wool tampon are safer means, and, as a rule, are perfectly efficient.

In extensive hypertrophy of the cervix amputation during pregnancy is indicated on account of the grave disturbances that are almost certain to arise during labor. There is, of course, under these conditions, some risk of abortion, but this accident is of insignificant moment compared with the serious obstacle opposed to dilatation in the long, thickened, indurated cervix.

Incomplete prolapse of the vagina, commonly affecting the anterior wall and causing vesical and vulvar irritation, indicate the use of astringent lotions and the cotton tampon saturated with glycerin and tannic acid. During labor the presenting part may force the prolapsed and hypertrophied vaginal walls through the vulvar orifice. The tumors thus formed, of variable size, sometimes constitute an obstacle to the advance of the child, or pressure-necrosis of the vaginal wall itself may follow. In the intervals between pains the tissue can be slipped over the presenting part, and during pains it may be held in position until the obstacle is passed. In other cases the timely application of the forceps fulfils the indication.

## HERNIÆ.

Herniæ of the pregnant uterus are very rare phenomena. Examples of the umbilical, inguinal, and femoral forms of the anomaly have been recorded.

In the later months the uterus may protrude through the umbilical ring into the sac of an old omphalocele. Murray[1] describes a case of this kind in which two-thirds of the uterus were thus situated. Olliver[1] reports a case in which the placenta was retained within the protruding uterus. In these, as also in a case recorded by Léotaud,[2] spontaneous delivery took place. Abdominal herniæ in consequence of diastasis of the recti and the yielding of cicatrices following abdominal section or injury have already been mentioned.

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[1] *Med. Times*, April, 1859, p. 406.

According to Eisenhart,[3] the first case of inguinal hernia of the gravid uterus was described by Nicolaus Pol in 1531; after Cæsarean section the mother lived three days, the child one and a half years. The second case, reported by Sennert, was subjected to Cæsarean section April, 1610, by Jer. Trautmann. The mother survived the operation twenty-five days, the child lived to be nine years old. Other cases have been reported by Saxtorph, Ledesma (1840), Rektorzik (1860), Scanzoni (1869).

Winckel has recently described a case of inguinal hernia of the pregnant right horn of a uterus bicornis. During the fifth month this horn was amputated and a dead fœtus removed. The patient recovered.

Almost always the hernia has been in existence prior to conception; in certain cases, however, the condition is observed only during pregnancy. Three distinct modes of origin may be recognized: (1) adhesions between the uterus and the intestine, which draw the former into the sac; (2) an ovarian hernia, which the uterus follows; (3) congenital hernia of the uterus.[4]

Femoral and inguinal herniæ of the gravid womb are readily recognized by the absence of the uterus from its usual position, the direction and shape of the vaginal portion and vagina, and the physical characters of the suspected tumor.

Reduction of these herniæ is usually impossible, on account of the adhesions or the volume of the uterus. Failing to replace the uterus, the induction of abortion is indicated. When the fœtus is viable Cæsarean section should be performed. Spiegelberg suggests incision of the neck of the sac and an attempt at reduction before Cæsarean section is performed. Schultze recommends Porro's operation. The latter expedient prevents a recurrence of the accident, and was entirely successful in Winckel's case.

## ANOMALIES OF THE VAGINA.

*Vaginal Leucorrhœa.*—Normally, the vaginal secretions are augmented during pregnancy at the same time with the hypertrophic changes in the mucous membrane, so that it is not uncommon to observe a condition in the perfectly healthy pregnant woman which in the non-gravid state would constitute a catarrhal vaginitis. Particularly during the second half of pregnancy a noteworthy papillary hypertrophy may occur. The examining finger detects little elevations, the size of a hempseed, disseminated over the entire surface. This condition was described by Deville in 1844 under the term "vaginitis granulosa," and was erroneously believed to be peculiar to pregnancy. The term applied by Deville is a misnomer, inasmuch as the condition is not an inflammation, but essentially a physiological hypertrophy of the papillæ of the mucous membrane.

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[1] *Western Journ. of Med.*, 1867.

[2] *Gaz. des Hôpit.*, 1859, No. 105.

[3] *Arch. f. Gyn.*, Bd. xxvi. Hft. 3, p. 439.

[4] Klob: *Path. An. d. Weibl. Sexualorgane*, Wien, 1864.

Often enough, vaginal leucorrhœa during pregnancy is of gonorrhœal origin. Then it is sometimes extraordinarily difficult to distinguish between the papillary hypertrophy just mentioned and the pointed condylomata of suspected gonorrhœa. In the latter disease, however, the discharge is apt to be more profuse, more distinctly purulent, and more irritating, while the vulvo-vaginal glands and urethra are apt to be involved. Finally, it is sometimes possible to detect the gonococcus of Neisser. Increased vaginal discharges may also be due to endocervicitis—a condition fully considered under Inflammation of the Endometrium during Pregnancy.

The slighter forms of vaginal leucorrhœa during pregnancy occasionally demand treatment on account of excoriations and itching about the vulvar orifice. Vaginal irrigation with tepid water, variously impregnated with alum, zinc sulphate, borax, carbolic acid, and the like, usually relieves the distressing symptoms. In more obstinate cases lotions containing corrosive sublimate in dilute solution are of undoubted value. A great degree of caution in the use of the cotton tampon is always necessary during pregnancy, on account of the reflex influence upon uterine contractions.

When gonorrhœal infection is at all probable, more energetic local treatment must be at once instituted, to prevent ophthalmia neonatorum as well as to ensure a normal puerperium. A 2 per cent. solution of argentic nitrate, thoroughly applied to every fold of mucous membrane by means of Braun's hard-rubber speculum, is a very efficient means. Corrosive sublimate is also of value under these conditions.

Winckel[1] has described under the term "colpohyperplasia cystica" a condition of the vaginal mucous membrane during pregnancy characterized by enormous quantities of small superficial cysts filled with gas, developed upon succulent hyperæmic bases and accompanied by hypersecretion.[2] Great diversity of opinion exists as to the exact pathological significance of this condition. Thus, Ruge terms the condition "kolpitis vesiculosa emphysematosa," and locates the little air-filled cysts in the spaces of the submucous connective tissue. Chiari, Spiegelberg [illegible], and others find the cysts in the lymph-spaces and in ectasiæ of the lymphatics. Zweifel, discovering trimethylamin in two cases, suggested the hypothesis that the gas was developed in the glands after the obliteration of their excretory ducts as the result of the penetration of certain germs. Häckel, V. Preuschen, and others have recently observed glandular epithelium in the cyst-wall, which would tend to confirm Zweifel's view. Aside from the pathological point of view, the condition, as remarked by Lebedeff, is of little practical interest. It commonly disappears during the puerperium, and seldom or never indicates special treatment.

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[1] *Arch. f. Gyn.*, Bd. ii. p. 383.

[2] Schroeder: *Archiv f. klin Med.*, xiii. p. [illegible]588.

Occasionally, catarrhal vaginitis during pregnancy is complicated by mycosis. White or grayish firmly-seated plaques upon red bases are observed about the nymphæ and introitus vaginæ. The two fungi most frequently noted are the Leptothrix vaginalis (Hausmann) and Oïdium albicans (Robin). While the former mycosis is ordinarily unattended by symptoms, itching, burning sensations of heat, and increased secretion are the common sequelæ of the latter. The infusorium Trichomonas vaginalis, so often found in the secretions of the part, is devoid of clinical import.

The treatment consists of vaginal irrigation with dilute solutions of carbolic acid (2 per cent.) or of corrosive sublimate (1 : 2000).

*Vegetations of the Vulva* are sometimes an annoying complication of pregnancy and labor. Acuminate condyloma is the result of the irritant action of gonorrhœal secretions upon the mucous membrane and skin in the majority of cases. But it is highly probable the condition may arise, in the absence of specific infection, from irritation by profuse catarrhal secretion and attrition of the opposed surfaces. Direct contact infection through the pointed wart itself during coitus has not been demonstrated. Duhring is responsible for the assertion that the pointed wart is "never a manifestation of constitutional syphilis."

During gestation the pointed wart grows with remarkable rapidity, not infrequently attaining a size sufficient seriously to complicate labor—seldom, indeed, as a mechanical obstacle to the advance of the child, but as a hindrance to dilatation of the perineum and as a cause of hemorrhage. The disease sometimes offers an obstinate resistance to treatment during pregnancy, but frequently disappears spontaneously during the puerperium. On account of the ease with which gestation may be interrupted, operative interference is contraindicated. The warts should be treated by washing with liquor sodæ chlorinatæ, afterward dusting with calomel, and isolation by means of absorbent cotton.

Allusion has already been made to the troublesome symptom of *pruritus vulvæ* during pregnancy. It is of importance not to mistake this disorder for other morbid states of which itching is a prominent symptom, and which are apt to make their appearance in this region.

Persistent itching about the genitalia should always lead to a careful local examination. In the majority of cases, as remarked by Duhring, the "diagnosis will in all probability be one of three diseases—eczema, pruritus, or phtheiriasis pubis." Pruritus is a functional disease of sensation of reflex origin, without structural alteration of the skin. The disease is of rare occurrence, although itching about the genitalia from the causes mentioned is frequently observed.

The treatment consists in the elimination of the cause as far as this is possible. When dependent upon the physiological changes in the genitalia, of course the therapy must be merely palliative. Under these conditions local treatment is of paramount importance. Local anæsthesia by means of cocaine is the most important measure. Goodell recommends injections of the decoction of tobacco. Bulkley extols the following ointment as efficient in many cases: ℞. Camphoræ, Chloratis hydratis, *āā*. ʒj; Ungt. aquæ rosæ, ℥j. M. The camphor and chloral should be rubbed together until fluid before the addition of the ointment. Carbolic acid, aconite, and the preparations of opium are also of decided value.

# THE PHYSIOLOGICAL AND CLINICAL PHENOMENA OF NATURAL LABOR.

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DEFINITION.—The variations in the mental, emotional, physical, and social characteristics and the circumstances of life of childbearing women are so multiform that it is impossible to define normal labor by the sharp lines of uniformity. It cannot be asserted that any two cases are identical, yet there is sufficient constancy in the course, progress, and termination of labor to establish a type which is recognized as normal in the physiological aspects of clinical history.

Labor is a natural process necessarily attended with more or less violence, and the physiological cannot always be distinguished from the morbid phenomena. It involves exertion which is associated with more or less suffering. These circumstances disturb, to a greater or less degree, the ordinary functional activities of the animal economy, so that even such apparently trivial conditions as unusual duration or precipitous progress may quickly transform an otherwise perfectly natural process into one of the gravest import.

Normal labor is ordinarily defined to be one that is effected by the natural effort of the female organism without artificial assistance, either manual, instrumental, or otherwise. But this definition must not be too sharply drawn; for the variations in duration, extent of traumatism, intensity and effect of the parturient effort and power are so numerous, and so easily influenced by diverse and intercurrent conditions of the woman, that it is far safer to regard every parturient woman as a sick woman exposed to dangers and complications which may imperil her safety.

Normal labor is the physiological termination of pregnancy, and is coincident with the maturity of the fœtus. To be natural there must exist such adaptability of the size, position, and presentation of the fœtus to the form and size of the birth-canal as will permit its passage to be effected by the voluntary and involuntary forces of parturition.

CAUSES OF LABOR.—The causes of labor are classified as determining and efficient.

The determining causes refer to conditions supposed to excite the expulsive efforts, and thus determine the beginning of actual labor. Very many theories have been advanced, but as yet none have been accepted as sufficiently plausible or scientific to adequately explain the termination of pregnancy and beginning of natural labor with such uniformity when the fœtus has reached maturity. Some have claimed the active agency of the fœtus in exciting uterine contractions, whilst others have maintained its absolute passiveness. Other investigators have ascribed the initial cause to fatty degeneration of the decidua; completion of the development of the muscular fibres of the uterus; reaction of the muscular structure against distension; accumulation of carbonic acid in the uterine sinuses; gradual expansion and obliteration of the cervical canal, and consequent pressure of the ovum upon the os uteri; and ovarian excitement, irritability of the uterus, and reflex influences. For a time the theory of uterine peristalsis, first advanced by Power, was accepted by many as satisfactory.

The motor impulses are derived from the sympathetic system and medulla oblongata. Hence it is entirely consistent with physiological law to infer that active uterine contractions may be induced by a variety of influences having their origin either in disturbances of the sympathetic system or in the motor centres in the medulla and cord.

The consensus of opinion in regard to the fallacy of some and weakness of all the suggested theories of causation predicates the conclusion that the initial cause must be sought in some combination of the conditions of utero-gestation, which, like the fœtus, have reached a stage of development and maturity when the activities are intensified or concentrated or a new force is evolved. Lusk offers the grouping of these conditions in the order of their relative frequency as a possible explanation. With the progress of pregnancy the irritability of the uterus is increased and the firmness of the attachment of the decidua is diminished. As labor approaches, the uterus more quickly responds to reflex stimuli, local irritation, and accumulation of carbonic acid in the blood. The tension of the uterine walls is continuously increased and the reaction of the muscular structure is intensified. The circulation is more easily disturbed and emotional sensibilities are more readily excited. Probable physiological separation of the decidua, resulting from repeated insensible contractions of the uterus, may partially convert the ovum into a foreign body, thus creating an active agency. The maturity of these preparatory changes and processes is coincident with the advent of labor.

*Efficient Causes of Labor.*—The contractions of the uterus constitute the essential, and are often the only, force employed in the expulsion of the fœtus. When the dilatation of the os uteri is complete, and the second stage of labor has begun, the propulsion of the fœtus is promoted by the action of the abdominal muscles. These conjoined forces may oftentimes be increased and prolonged by the well-directed bearing-down efforts of the parturient. When delivery is accomplished during narcotism, the uterine contractions are unaided by the voluntary contractions of the abdominal muscles, but it does not necessarily follow that the duration of the labor is prolonged. In some cases, especially in primigravidæ, anæsthesia eliminates disturbing influences and intensifies the contractions of the uterus. In such cases labor is expedited.

PRECURSORY SYMPTOMS OF LABOR.—These are variable and inconstant, and rarely of special significance. In many cases labor begins abruptly with strong uterine contractions. Sometimes the patient is awakened from a profound sleep either by a sharp pain or the escape of the amniotic fluid, and labor progresses rapidly to a satisfactory termination. Perhaps in a majority of cases labor is preceded by some change in the contour of the abdomen, but it is not always sufficiently marked to be observed even by the patient. In the primiparæ with roomy pelves the descent of the uterine tumor is most observable because of the entrance of the lower segment of the uterus into the pelvic cavity, and is most marked by the diminished tension of the abdominal walls, lessened pressure against the diaphragm and upon the stomach, and, perhaps, by the consequent increased frequency of micturition, greater swelling of the lower extremities, and greater inconvenience in walking. Some women during a few days, and others during a longer period, immediately preceding the advent of labor are more or less annoyed with what are commonly called "false pains." They usually, more especially in multiparæ, occur during the earlier hours of the night, disturb the rest, and disappear to recur the succeeding and perhaps for several nights, and then may cease entirely. They are irregular in time, duration, and degree, and are unassociated with dilatation of the os uteri or show of blood. With obliteration of the cervix, regularly-recurring pains, and dilatation of the os, labor has begun.

The most constant precursory signs are increased secretions from the cervical and vaginal glands and swelling of the labia. These secretions vary greatly in quantity in different women. In obese women they are more abundant, and in some are more or less acrid. The viscid and yellowish discharge from the glands of the cervix is occasionally stained with blood. The vaginal secretion is mainly dependent upon the pressure of the gravid womb and consequent congestion of the soft parts.

THE STAGES OF LABOR.—The period of labor is divided into three stages—first, second, and third. The first is the stage of dilatation of the os uteri; the second is the stage of expulsion, and comprises the period from the complete dilatation of the os uteri to the extrusion of the fœtus; and the third is the stage of placental detachment and delivery and contraction of the uterus. Ordinarily, the description of the third stage is limited to the delivery of the placenta, because, fortunately in most cases, the contraction of the uterus progresses with its detachment, and is completed with its extrusion through the os; but for reasons too apparent to require recital here it should not be considered as terminated until firm and persistent contraction of the uterus is established and secured.

THE PHENOMENA OF LABOR.—The phenomena of labor are divided into the physiological, mechanical, and plastic. The consideration of the physiological phenomena must necessarily precede the description of the clinical history of the several stages of labor. The mechanical phenomena will be discussed in the article on the Mechanism of Labor.

*The Contractions of the Uterus.*—These contractions are entirely independent of the will, yet they are frequently influenced by mental and other intercurrent conditions. Any sudden surprise, a disagreeable communication, or the unexpected entrance of a person into the chamber may suspend or lessen, for a time, their power. The first visit of the accoucheur will very often arrest them. In the beginning they are slow, weak, short, and at long intervals, especially so in primiparæ. Sometimes they will cease for a shorter or longer time, to return with increased violence and duration. Each contraction begins and gradually increases to its maximum intensity, and then gradually subsides to complete quiescence. As the labor progresses they increase in frequency, duration, and power.

Intermittence is a special and important characteristic. In the earlier period they may not continue longer than twenty seconds; in the later, as long as one minute or more. During the intermission the muscular structure of the uterus relaxes and the organ resumes its ovoid contour. As they increase in intensity the intermission is shortened, but they never become continuous, except perhaps when the head is about to escape the vulvar orifice, when the duration is greatly prolonged, followed by sudden cessation with the passage of the head, and a longer pause.

Intermittence is a wise provision of nature. It enables the patient to regain strength, recuperates vigor, and prevents demoralization. Respiration, though increased in frequency, is fuller and freer than during the contraction, and the disturbed circulation is equalized. During the pain the pulse is increased in frequency, arterial tension is increased, the face is suffused, respiration is interrupted, the lungs are in a state of partial or complete expansion, the diaphragm is depressed, and the general muscular system is maintained in the condition of tonic rigidity. During the intermission respiration is restored, the color of the face disappears or lessens, the pulse slows, arterial tension diminishes, and there is relaxation of the muscular system. Continuous contraction would inevitably lead rapidly to disastrous consequences. No woman could survive such a condition during an ordinary labor, or even for any considerable time, without artificial interference; and no womb could resist rupture. Intermittence promotes the advance of labor; tonic contraction arrests progress. It is also a conservator of the life of the child. Persistent contraction produces continuous pressure upon the child, which would cause asphyxia and death.

Some maintain that the contractions are peristaltic, beginning either in the fundus or neck and extending toward the opposite pole. Others insist that the uterus contracts simultaneously in all of its parts. If the wave of persistalsis exists, it extends from pole to pole with marvellous rapidity.

The force of the contraction increases with the progress of labor. The greater the power, the shorter the intermission. With increased resistance the intensity of suffering and force of the contraction are augmented. Beginning with barely perceptible pain, the suffering continuously intensifies until the maximum degree of agony is reached just at the moment when the parietal eminences pass the vulvar orifice, followed by abrupt cessation of the indescribable anguish, with joyful exclamations of relief.

In vertex presentations the contractions of the uterus are more regular and effective. The uniform expansion of the lower segment of the uterus and pressure upon the dilating os evolve force and promote regularity of action. They are also more effective because of the more complete adaptation of the diameters of the head to those of the birth-canal. The uniformity of pressure and action excites the contractions of the abdominal muscles and enhances the value of this accessory force.

*The Action of the Contractions upon the Walls of the Uterus.*—During the contractions the form of the uterus is changed from an ovoid to a globular shape. The transverse diameter is diminished, whilst the longitudinal and antero-posterior are increased. This change in the form of the uterus extends the fœtus. The continuously increasing thinness of the lower segment of the uterine walls permits increasing downward stretching, and with diminution of the bulk of the organ there is increased thickness of the walls of the body and fundus. These changes in form and size push the uterus forward against the abdominal walls.

*The Accessory Forces.*—The contractions of the abdominal muscles are the most important of these auxiliary forces. During the first stage of labor, while the dilatation of the cervix and os is in progress, the contractile movements of the abdominal muscles are barely appreciable either to the patient or observer; but with the onset of the second stage, and during the progress of the expulsive period, they are greatly increased in power, and contribute effective assistance to the expellent uterine contractions by fixing the organ in position and firmly pressing it downward in the direction of the axis of the superior strait of the pelvis. During the stage of dilatation they are, probably, wholly independent of the will, but during the second stage they are in a marked degree controlled in effectiveness, if not in evolution, by the volition and conduct of the patient. When the concluding moments of the expulsive period have arrived, and the alternate recessions of the advancing head have ceased, they assume a distinct reflex character, and constitute the predominant factor in maintaining the continuity of effect and effort during the passage of the head through the vulvar orifice. The influence and control of the patient are exhibited in the voluntary fixation and position of the body and limbs, full inspiration, suppression of outcry, pressure of the feet against some fixed support, and grasp of the hands of attendants or any object within reach preparatory to the evolution of the contributing bearing-down effort. The involuntary closure of the glottis, depression of the diaphragm, and general tonic muscular rigidity are unavoidable accompaniments of appreciable utility.

The conduct and position of the patient are not without value as aids in expediting and making effective the voluntary and involuntary forces of labor. The woman who tosses about the bed screaming with the utmost vehemence, or lies in rigid extension during the pains, wastes force and time and invites exhaustion, usually taxes the patience and endurance of the accoucheur to its utmost tension, and hastens the employment of instruments. Englemann has demonstrated the value of position in natural labors, but change of posture may often be utilized as a coefficient in accelerating delivery. As a rule, the left lateral position, with the thighs flexed upon the trunk and legs upon the thighs, is preferable, because more convenient for the ordinary manipulations and observations, and bringing the direction of the involuntary and accessory forces into more direct parallelism with the utero-pelv axis through which descent of the head and delivery of the child mu be accomplished.

The round and broad ligaments contain muscular fibres continuou with the muscular structure of the external layer of the uterine walls and are simultaneously engaged in the contractions of the organ. The action of these supports is to fix and depress the uterus, holding it firmly in position with the fundus forward against the abdominal walls and the lower segment in the pelvic brim.

The expellent forces originate and consummate the process and progress of natural labor. It is true that in the beginning propulsion does not markedly characterize uterine contraction, but labor is an entirety, comprehending the successive stages of preparation, progress, and completion. Each force is the adjuvant of the others, and each finds its corollary in the anatomical relations and structural conditions of the parts concerned. The uterus is a hollow muscular organ, with a single expansile outlet at its most dependent part, and with walls of varying thickness and elastic and contractile properties. It is filled to repletion with a solid body floating in a liquid contained in a closed sac attached to its inner surface. If its contraction were uniform and equal in force throughout, compression of its contents would be the only result. But as the lower segment terminates in a dilatable orifice, is thinner, more expansible and elastic than the fundus and body, the force of compression is necessarily expended upon it. The expansile outlet yields with each successive contraction, and the presenting head descends toward the yielding and bulging inferior segment. The concentric pressure of the uterus is exerted mainly, if not solely, upon the peripheral liquid contents of the amniotic sac; and that portion of the fluid occupying the thinned, elastic, and distended segment is imprisoned by the close coaptation of the descending head with the uterine walls; consequently, increased tension and protrusion of the sac at the point where the resistance is removed. With the continuously increasing tension of the lower segment during the successive contractions, and simultaneous thickening and retraction of the walls of the body and fundus, and lessening of the organ in all of its diameters during the process of extrusion of the fœtus, detachment of the placenta and secundines takes place.

The uterus also possesses the inherent property of retraction. This is due to the continuous change in the muscular fibres of the upper segment which takes place during labor. In the lower segment the fibres are stretched and lengthened; in the upper they are shortened and the walls thickened. As the gradual retraction, with thickening and condensation of the walls, proceeds, the stretching and tension of the lower segment increase, thus, in some measure, promoting the dilatation of the cervix and os. The ridge of Bandl, the existence of which is disputed, is supposed to define the limit between the upper and lower zones. The positive property of retraction resides in that portion above this alleged ridge, and the indirect effect upon the cervical canal is due to the insertion of some of the longitudinal muscular fibres of the lower segment in the cervix, which are subjected to increased tension because of the continuously increasing and partially permanent stretching of the walls of the lower zone.

*Force of Uterine Contractions.*—Various attempts have been made to measure the force of uterine contractions, but none have proven satisfactory. Poppel estimated the force exerted in easy labors at from 4 to 19 pounds; Duncan, at from 6 to 27 pounds. Duncan concludes that in a majority of labors the propelling force does not exceed 40 pounds. Poullet estimates the maximum force of expulsion at 50 pounds. Schatz's investigations led him to the conclusion that the force varied from 17 to 55 pounds. The conclusions of Poppel and Duncan point to the fact that in many easy labors the force does not exceed the weight of the fœtus. The force employed is necessarily dependent upon the amount of resistance, which is influenced by a variety of conditions referable either to the child or mother.

*Pain.*—With rare exceptions, childbirth is attended with more or less pain from its beginning to its termination. Some women fret, toss, and scream with every uterine contraction; others will bear the most intense agony in quiet and without complaint. Some feel pain more acutely than others, and exhibit suffering in such intensity as to invoke the most profound sympathy and commiseration. Primiparæ suffer more than multiparæ. The pains are synchronous with uterine contractions, and "labor-pains" is the ordinary expression indicating such action of the uterus; but the suffering does not actually begin with the commencement of the contraction, and terminates before it has subsided. In other words, the duration of actual and manifest pain is less than that of the contraction.

During the earlier period of dilatation of the cervical canal the pains are very slight, barely manifest to an observer. The patient may for a moment suspend conversation or any employment in which she may be engaged, and perhaps there may be some trivial change of expression and posture. If sitting she may lean forward, or if standing stoop slightly. Such temporary interruption will be followed by resumption of conversation or employment and apparent perfect self-possession. The painful periods increase in duration, frequency, and intensity. During the stage of dilatation they are described as worrying, cutting, teasing, or grinding, at first felt in the lumbar and sacral regions, then radiating toward the pubes, encircling the body, and finally passing, by a gradual transition, into bearing-down expulsive efforts, with markedly increased suffering during the progress of labor. At first the pains are actually located in the lower segment, but during the second stage they invade the body and fundus and are distinctly felt in the uterine tumor. The ordeal of suffering is soon forgotten after the labor is over, and many approach a second confinement with less trepidation, but in others the fear is greatly increased. The manifestations of suffering are more influenced by mental and emotional than by physical conditions. Delicate and feeble women often pass through the travail of labor with composure and heroism, whilst the robust and healthy often exhibit their suffering in the most exaggerated manner.

*False Pains.*—Sometimes, near the approach of labor, pregnant women are seized with pains which may be mistaken for labor-pains. Such seizures are known as "false pains," and are to be distinguished from the pains of labor by their situation, usually in some part of the abdomen, their irregularity in time and degree, their disassociation with dilatation of the os, and the absence of any "show."

*Dilatation of the Cervix and Os.*—Labor begins with painful contractions of the uterus, and with these contractions commences the process of dilatation of the cervix and os. The pains are usually very slight in the beginning, but gradually increase in frequency, duration, and intensity. The woman is not confined to the bed, but most often is sitting up, and during the intervals walking about her chamber. With the onset of the contraction she quickly returns to the chair, bends forward, with her hands pressing upon her hips or sacrum or upon her knees, or leans forward, resting herself upon the back of a chair. With the subsidence of the pain she resumes the cheerfulness and complacency of freedom from discomfort, and not infrequently engages in pleasant conversation with those present. The intervals of relief and periods of suffering recur in quick succession. With each recurring contraction the process of dilatation progresses: beginning at the internal os, it gradually encroaches upon the cavity of the cervix until the pressure reaches the external os, which slowly increases in diameter, with thinning of the lips and the formation and protrusion of the bag of waters. As a rule, when the dilatation is complete, perhaps reaching three or three and a half inches in diameter, spontaneous rupture of the amniotic sac takes place, with a copious discharge of fluid; then follows the second stage of labor. As the process of dilatation of the external os increases, the secretion is stained more or less with blood, most often due to slight lacerations of the os, but this may, when freer, be caused by a serious laceration of the cervix or a partial detachment of the lower segment of the placenta when its implantation invades or encroaches upon the cervical zone. The end of the first stage cannot always be accurately defined. There is usually a short pause between the conclusion of the first and the beginning of the second; but very often the transition is so gradual that the precise moment of the commencement of the second stage cannot be fixed.

*The Bag of Waters.*—The formation of the bag of waters occurs during the first stage, and is one of the most constant physiological phenomena of the process of dilatation. When the rupture of the membranes occurs previous to or at the onset of labor, a partial discharge of the amniotic fluid takes place. Such cases are known as dry labors, and are slower in their progress than when the sac remains intact until dilatation is completed. As the dilatation of the os increases the resistance is diminished, and with each succeeding contraction of the uterus the quantity of amniotic fluid in the dependent part of the sac is increased and imprisoned by the pressure and ball-valve action of the presenting part of the fœtus. In consequence of the continuous lessening, and the final removal, of the resistance by the expansion of the os, a portion of the sac protrudes, forming a more or less hemispherical bag, which by its continuously increasing size and length promotes dilatation of the os and, but to a much lesser degree, of the vagina. The size and form of the bag of waters are dependent upon the condition of the os, the amount of the liquor amnii, the tensile strength of the membranes, the power of uterine contractions, and the presenting part of the fœtus. In head and breech presentations the membranous bag is more or less hemispherical, and more or less regular in contour, according to the presence and extent of the lacerations of the cervix and shape of the os. In breech cases the bag is usually less tense, but more voluminous, than in head presentations, because of the imperfect closure of the lower uterine segment; and when the os is rigid it may be elongated. In cases of the extension of an extremity, with persistence of the membranes, there would be an elongation of the pouch, and the shape of the most dependent part might indicate the presence of a hand or foot. Madame Lachapelle declared she was never anxious when "the flat sac" was present, thereby meaning, says Cazeaux, that any "very great protrusion of it nearly always announces an unfavorable position" of the fœtus.

Spontaneous rupture of the membranes usually takes place in the part protruding through the os, most frequently at or about the most dependent point or apex of the bag of waters, because at this point the pressure-force of the compressed liquid is greatest and the resistance least. Too early evacuation of the liquor amnii retards dilatation of the os, prolongs labor, intensifies the suffering of the woman, increases the risks of the fœtus, and augments the difficulties and dangers of efforts to correct transverse and other abnormal presentations. Protracted persistence of the membranes wastes uterine power, lessens its propulsive force, delays retraction of the cervix, and may prevent the engagement of the presenting part. The tensile strength of the membranes varies from four to thirty-seven and a half pounds. The propulsive force which bursts the bag of waters is frequently, in natural labors, quite sufficient to complete delivery; hence it is obvious that in many such labors the ovum would be expelled with membranes entire if artificial rupture had not been accomplished. In those cases of persistent membranes where the tensile strength is at or near its maximum, or even above the average, it is equally obvious that delivery is delayed, and there is an unnecessary expenditure of uterine force with consequent exhaustion, which is proportionate to the duration of the persistence of the membranes and vigor of the patient. In no case should the bag be permitted to advance in its integrity beyond the external surface, and in many cases an earlier discharge of the waters will be expedient. The puncture of the membranes should always be made at or as near as possible to the central portion. The tear does not, however, even when spontaneous, always take place at the most dependent part of the pouch, or even external to the os. When located high within the cavity of the uterus, there may be persistence of the bag of waters notwithstanding the gradual discharge of liquor amnii. In such cases the child may be born with a "caul," which is nothing more than a detached portion of the membranes, of variable size, coaptated to the scalp. Expulsion of the ovum "at term" with the membranes intact should not be permitted, and when, as in very rare instances, it does occur, the child should be immediately liberated by tearing away the sac of membranes. The value of the bag of waters as a vaginal dilator is a mooted question. In cases of persistence it can hardly compensate for the delay occasioned by obstructing the escape of the presenting part through a dilated os. It is not always easy to decide whether the membranes have been ruptured or not, and very grave mistakes have been made by careless and indifferent attendants. The tension of the sac, with more or less protrusion through the dilating os during the pains, together with the stretched and thinned margin of the os, and the relaxation and flabbiness, and perhaps entire disappearance, of the pouch during the intervals, will ordinarily differentiate a persistent sac; but in rare cases, either because of the smallness of the quantity of the liquor amnii or the close adjustment of the ball-valve action of head presentations, very little or no fluid settles in the lower segment of the uterus between the descending head and underlying portion of the amniotic sac. In the former case the intact membranes may be made out by careful examination during the intensity of the uterine contraction, when the interposed fluid, however small, may be recognized by the tension and contour of the membranes. When the membranes are closely applied to the scalp, and no fluid can be discovered during the pain, the membranes may, during the intervals, be pushed into irregularities, or a finger may be inserted between the head and the cervix, thus opening a channel for the escape of fluid if the sac has been ruptured.

The dilatation of the cervix is not entirely a mechanical process. As previously stated, some of the longitudinal fibres of the lower segment of the uterus are inserted into the cervix, and the tension of such fibres consequent upon the continuous stretching of the segment influences dilatation. Dilatation is furthermore promoted by the organic changes which take place in the cervix, due to infiltration of its structure with serum, and consequent softening, increased distensibility, and lessened resistance.

THE SECOND, OR STAGE OF EXPULSION.—This is the utero-abdominal period of labor. The contractions of the uterus increase in force, frequency, and duration, and assume a propulsive character. With each contraction the head descends along the parturient canal and the cervix recedes. The expulsive power of the uterus is reinforced by the contractions of the abdominal muscles, which, though not entirely absent during the first, are greatly intensified during this stage. These forces are independent of the will. The progress of expulsion is not continuous, but only during the utero-abdominal contractions. With the subsidence of each pain the head recedes, and during the intervals the parts remain quiescent. Notwithstanding the recession, some advance is made with every effort. As the head passes the pelvic outlet the vagina is dilated and the perineum begins to stretch. When it has passed the outlet and is only covered by the soft parts, the perineum is distended and the vulvar orifice begins to open. With each succeeding contraction, which is usually increased in force at this period, the tension of the perineum increases, the vulvar opening expands, exposing to view a part of the head. The urethra is pushed upward; the anus is stretched; feces are expelled from the rectum; and the perineum and labia are thinned to such degree that the sutures may be easily traced. With each pain the expansion of the vulvar orifice exposes a larger area of the head, and finally, at the acme of a contraction, the head is born. There is always more or less laceration of the perineum. In a comparatively few cases it does not involve the muscular structure of the perineum, and may be limited to the fourchette, but frequently it is much more extensive. With the next or succeeding pain the shoulders escape and the child is extruded, followed immediately by a copious discharge of the amniotic fluid mixed with more or less blood, due to the partial or complete separation of the placenta. The cries of the child and sudden sense of relief announce to the mother the birth of her child, to which she responds with expressions of joy and gratitude. In some cases with the complete expulsion of the child the placenta is discharged into the vagina and the uterus is firmly contracted. Sometimes, in consequence of the sudden evacuation of the uterus and consequent diminution of the intra-abdominal pressure with the flow of blood to the abdominal vessels, faintness occurs. With the delivery of the child there is sudden and complete cessation of the violent utero-abdominal contractions, followed by a period of rest and repose sufficiently long to allow deliberate attention to the child by the ligation and separation of the cord and its removal. Then follows the third or placental stage.

With the descent and escape of the head through the os the vagina is dilated. But little if any resistance is offered until the vaginal orifice is reached. In some cases this presents an appreciable obstruction, which may occasion some delay in the progress of labor. As this orifice yields, the vulva, perineum, and vulvar opening undergo the process of dilatation, which in primiparæ is always attended with more or less injury.

THE THIRD, OR STAGE OF PLACENTAL DELIVERY.—The usual statement is that after the expulsion of the fœtus a short period of complete relief from pain follows; then the stage of placental expulsion begins with a slight painful contraction of the uterus, reinforced by an equally slight contraction of the abdominal muscles. Whether or not the necessary attention to the cord and separation of the child belongs to the second or third stage is immaterial in its practical aspects, but the fact is that in a majority of cases the cord is ligated and severed before the uterus resumes its contractions. In some cases the cessation of pain with the delivery of the fœtus is continuous, because with the final expellent effort the placenta is forced out of the uterus into the vagina, from which it is afterward discharged; and in rarer instances it is expelled externally simultaneously with the child. But whilst the period of placental extrusion in the greater number of natural labors is unattended with any circumstance demanding special attention, it is, nevertheless, a period of vigilant anxiety, for notwithstanding the labor may have been perfectly natural during its previous history, without the occurrence of a trivial interruption, the accoucheur may be suddenly confronted with one of several formidable and dangerous complications. In natural labors, when the delivery of the placenta is accomplished solely by the contractions of the uterus and abdominal muscles, it usually presents at the uterine orifice folded on itself with the margin inserted or projecting through the dilated and flabby os. But when traction on the cord is made prematurely or otherwise improperly, or by a shortened or coiled funis, the fœtal surface presents at the point of attachment of the cord, with the mass reflected backward on its maternal surface, thus forming a larger bulk less easy to extricate. With delivery of the placenta and secundines there follow some blood-clots and more or less fluid blood which escapes from the placental site. The removal of the placenta from the vagina, and even its removal when found extruding from the birth-canal, should be done with great care and gentleness or portions of the membranes may be detached and left in the cavity of the uterus. After removal it should be carefully examined to ascertain if the delivery is complete and no fragments of the secundines have been left to interrupt and complicate the convalescence of the patient.

The detachment of the placenta takes place in the meshy layer of the serotina and is caused by the retraction of the muscular walls. It has not been settled whether the separation begins at the margin, in the centre, or simultaneously at various points. The maternal vessels are unavoidably torn by the detachment, but hemorrhage is prevented and arrested by the formation of coagula in the torn vessels and condensation of the uterine structure.

The Effects of Labor upon the Mother.—In addition to the effects of parturition upon the circulation and respiration, before referred to, the female organism suffers other not less marked influences. It may, in fact, be stated that all the functions are more or less disturbed. Not infrequently, nausea and vomiting during the early stage are harassing perturbations, but do not betoken evil unless persistent and prolonged during the later stage, when consequent exhaustion and uterine inertia may seriously complicate the labor. The appetite is always lessened and generally wholly absent. The secretion of urine is usually increased, especially during the early stage, and quite often becomes a troublesome annoyance. The perspiration is increased, and during the expulsive period the surface is bathed with moisture. The temperature is elevated. Weight is diminished as the result of the evacuation of the uterus, loss of blood, increased cutaneous exhalation, and secretion of urine. Few women bear the pain of labor with composure. Mental disturbance, though most often of a trivial character, is a common accompaniment of parturition. Some are inspired with hope and exhibit courage and heroism; more often fright and evil forebodings augment the agony of suffering, increase exhaustion, and slow the progress of labor. Will-power and self-control are important adjuvants to uterine contraction and the accessory forces. Emotional conditions, so common among the coddled and luxurious primiparæ, are perplexing and vexatious complications. The functional and imaginary perturbations are so varied and multiform that natural labor among this class of females has become phenomenal.

The Effects of Labor upon the Fœtus.—During uterine contractions the fœtus is compressed. The placental circulation is partially interrupted, the fœtal heart-beats are slowed, and partial asphyxia ensues. The head is also compressed, the bladder may be evacuated, and meconium may be discharged from the rectum. During the intermittence the pressure is removed or lessened, and the fœtal and placental circulations are relieved. The passage of the head through the pelvis effects changes in its form, marked by diminution of some and increase of other diameters, and the formation of the caput succedaneum. This is a tumor of the scalp located on that part not subjected to pressure during its passage through the pelvic canal. In anterior vertex presentations it will be found, when present, upon either the right or left parietal bone. It is an œdematous swelling, pits on pressure, but does not fluctuate.

Duration of Labor.—The duration of labor is influenced by a great variety of conditions and circumstances which refer to both mother and child. Age, race, climate, civilization, circumstances of life, mode and manner of living, physical conformation and condition, heredity, primiparity and multiparity, as also the size, presentation, and position of the fœtus, are the most common and important factors which determine the duration of labor. First labors are longer than subsequent ones. Early primiparity is more favorable than late primiparity. Duration is increased by protracted intervals between pregnancies, and long intervals between late pregnancies protract labor more than long intervals between early pregnancies. Too early and too late primiparity increase the duration of labor. The periods of greatest fecundity and fertility mark the epoch of highest physiological and formative energy, most abundant recuperative resources, and maximum powers of endurance and resistance, and consequently define the period of life during which childbearing is most favorable in regard to duration of labor as well as to the survival and longevity of the patient.

The average duration of all labors is from twelve to fifteen hours; in primiparæ it varies from twelve to twenty-four hours; in the multiparæ, from six to twelve hours. There are, however, many exceptions to this statement of the general average. The writer has witnessed a labor in a young primipara not exceeding one and a half hours, without detriment to either mother or child and followed by a normal convalescence. Since the introduction of anæsthetics in obstetrics, and the more frequent and skilful employment of the forceps, protracted duration is but rarely, and then often not wisely, witnessed.

The stages of labor shorten in succession. The first is usually three times as long as the second, and the third much shorter than the second.

## The Conduct of Labor.

Childbearing is a natural process, but in civilized life, more especially in the higher walks of society, the female organism but rarely performs its duty satisfactorily without intelligent assistance. Meddlesome interference often commits mistakes, and blind expectancy omits many opportunities to promote the progress of the process and to mitigate the sufferings of the patient. The essential prerequisites of the skilful and successful obstetrician are competency, deliberation, alertness, promptness, and self-possession. Women in labor are very impressible and quick to observe, and wrongly interpret even trivial indiscretions of word and act. The confidence of the patient in the qualifications of her attendant obviates many emotional disturbances, conduces to the harmonious succession of the physiological phenomena, and completes the equipment of the woman for the ordeal of agony through which the blessings of maternity can only be attained.

Ignorance, rashness, and pretentious inertness are inexcusable in the lying-in chamber. Complications may be averted by intelligent vigilance, but the emergencies are too sudden in their advent to await the sloth and wrong of ignorance. Competency does not relate solely to a knowledge of the mechanism of labor, but must comprehend the minor details of management. A woman in labor is entitled to the full and complete discharge of every duty which is necessary or essential to her welfare, and a physician who is unfitted or unwilling to render such service should not be permitted to jeopardize her safety and life.

It is assumed that the attendance of the obstetrician has been engaged several months before the advent of labor, and that her health and the surrounding circumstances and hygienic conditions have been subjected to such supervision and management as may have been necessary to conduct her safely through the period of pregnancy and bring her to the beginning of her labor in the most satisfactory condition of health. Even in those rare cases among the primigravidæ whose period of utero-gestation has been free from the ordinary functional disturbances much good may often be accomplished by judicious explanation of the current events of parturition, and the assurance that courage and a good *morale* are important adjuvants in securing a favorable progress and termination of her labor.

*Nurse.*—The obstetrician should know that a competent nurse has been selected, and that she has become sufficiently acquainted with the patient to win her confidence. The time for "grannies" and superstitious intermeddlers in the lying-in chamber has fortunately passed, and the new régime of skilled and trained nurses has come to aid the accoucheur and contribute to the comfort and safety of childbearing women. The physician who will gratify the whims of capricious women by the selection of incompetent and inefficient lying-in nurses will have many occasions to regret his dereliction of duty.

*Preparation.*—At some convenient time, not long before that approximately fixed for the labor, the physician should direct the patient, or, better, some intelligent and confidential household companion, to obtain and put away in some safe and convenient place a small quantity of the fluid extract of ergot and Monsel's solution of iron or the persulphate of iron in mass, an anæsthetic—the usual combination of alcohol, chloroform, and sulphuric ether is preferred by the writer—some whiskey or brandy, a Davidson's syringe, several small well-washed surgical sponges, and one or more large, soft, coarse sponges to absorb the discharges and prevent unnecessary soiling of the pads and bedding. If these articles have not been provided, he should supply himself with them at his first visit, and also with a pair of forceps, a silver female and a flexible catheter, hypodermatic syringe, sulphate of morphia, needles, needle-holder, and silk and wire. Ice and hot and cold water should also be in readiness for immediate use.

*Room.*—The lying-in room should be large, dry, well ventilated, well lighted, and above the ground floor, and in a dwelling equally faultless in regard to ventilation, dryness, sunlight, and freedom from noxious effluvia, sewer gas, or other deleterious exhalations. All unnecessary hangings which obstruct ventilation and sunlight and afford a nidus for the collection of pernicious emanations should be removed. Sunshine promotes diffusion and purifies the air, and, in certain seasons, affords sufficient heat. A room with a southern exposure is the most desirable, because the good effects of the solar influences and dryness are more constantly and easily secured. It should be heated by an open fire when necessary, and care should be taken to exclude the air of the house, which must, of necessity, be to a greater or less extent contaminated. When artificially heated it is usually the warmest room in the house, and, as the current of air from the lower apartments, closets, and cellar is in the direction of the greatest heat, the lying-in chamber, as a consequence, becomes the common receptacle of the noxious effluvia of the house. External ventilation and internal meteorology are not less important than domiciliary sanitation. When the atmospheric conditions are unfavorable and open-air ventilation is inadmissible, or at least only available to a limited extent, the meteorology of the room can be improved by excluding the foul air of the domicile and heating the room with an open fire, which warms and dries the air and promotes diffusion and ventilation.

*First Visit.*—The first visit of the accoucheur, as well as his subsequent conduct, should be characterized by circumspection, gentleness of manner, affability, and a courteous regard for the innate modesty and sensibilities of women. Personal cleanliness and neatness of dress inspire the patient with respect and admiration. The odors of tobacco and alcohol are obnoxious to many well-bred women, and sometimes the first whiff of an alcoholic breath will shake her confidence and quickly induce manifest discontent. After a pleasant and well-chosen remark or two to secure her attention and quiet surprise, he should calmly and courteously introduce the object of his visit by pertinent inquiries in regard to her condition, with special reference to the frequency, location, duration, and intensity of her pains, together with such general inquiries and observations as may indicate his interest in her case and sympathy for one whom he is to conduct safely through her travail. When such preliminary conversation has been finished, at his suggestion the nurse will arrange the patient in bed, preferably in the left lateral position, preparatory for a vaginal exploration. In the mean time, in another room to which he has retired, he should thoroughly cleanse his hands, wipe them dry with a clean towel, and then bathe them with some disinfecting fluid. When summoned by the nurse, with the index and second fingers of the right hand lubricated with carbolized vaseline or other innocuous substance, and a clean towel to conceal his hand after the examination, he should approach the bedside in an unobtrusive manner and explain to the patient, especially if a primipara, the object of the examination, its necessity for his guidance and her welfare, with the assurance that it need not occasion pain. This exploration should begin during an interval, but may continue through the succeeding pain, and should determine whether labor has begun, and if so, its progress. It should be sufficiently complete to ascertain the extent of dilatation and the condition of the cervix and os, presentation and position of the fœtus, hardness and flexibility of the head, size and condition of the pelvis, length of the vagina, amount of vaginal secretion, presence of fecal masses in the rectum, effect of the pains, and state of the bladder, perineum, and vulva. The vaginal examination should be as thorough as possible without needlessly worrying the patient and exciting by too long continuance the suspicion of something wrong. It is advisable, though not always expedient with primiparæ at this stage, to confirm the diagnosis of position and presentation of the fœtus by abdominal palpation, and in the case of failure to make such diagnosis by vaginal exploration—rare with careful and experienced obstetricians—abdominal palpation should be insisted on. An early diagnosis is imperative. After having completed it, such frank statements of a favorable condition should be made to her as truth and conscience will permit. The simple declaration that "all is right," uttered in a confident and assuring manner, may obviate a panic and inspire her with feelings of actual pleasure. Lying is never permissible, but in unfavorable cases reserve, tact, and caution are available expedients to afford escape from direct questions. Whatever communication is made should be accompanied with the emphatic statement that the progress and duration of her labor will necessarily depend upon the character of the pains, and in some measure upon her submission to the inevitable suffering, and that he will render every proper service to lessen the duration and intensity of such suffering.

*Absence.*—Having acquired the necessary information, she may be required to remain in bed or resume the sitting posture, walk about the room, and engage in such harmless diversion as may seem expedient. It may not be necessary, and is not always wise, for the obstetrician to remain in the room or house, but before leaving the house he should direct how the bed is to be prepared and ascertain that all the necessary appurtenances for the care of the patient during and after her confinement are in readiness; that a pair of scissors and a ligature are conveniently placed for his use in securing the cord; and that the clothing of the child is properly prepared and ready for use. He should indicate the time of his return, and how and where he may be found should his presence be required before the expiration of the stated time of absence.

*Bed and Bedstead.*—Attention to the location of the bedstead and preparation of the bed are important. High head- and foot-boards are inconvenient annoyances, obstructing easy and proper handling of the patient. The bedstead should be so placed as to afford every facility to the accoucheur and nurse for access to, and care of, the patient, and to secure good light when and where needed, without exposing her face to the glare of artificial or sun light or her person to draughts of air.

Feather beds are an abomination, and spring mattresses are not less objectionable. A good, smooth, easy, and firm mattress of hair, free from irregularities, lumps, and depressions, with one or more good pillows, clean sheets of cotton cloth, and a safe and firm bedstead, will supply all the necessary appurtenances of a good bed. Over the mattress should be spread a sheet, upon which an impervious cloth of sufficient size to protect it and the mattress from the discharges should be smoothly laid and fastened at each corner to the mattress with safety pins. Upon this should be laid a thick and soft pad of such material as will rapidly absorb the discharges. Then the upper sheet and such other bed-clothing as will be necessary to cover and protect the patient from exposure, so arranged as to be easily removed and readjusted as occasion may require, should be added. Blankets should always be in readiness, for flushes of heat and sensations of cold are common accompaniments of parturition.

*Antisepsis.*—These preparatory arrangements, which refer to the comfort and security of the patient and to the convenience of the accoucheur, must be supplemented by an equally complete preparation for, and assiduous application of the principles and practices of, antiseptic midwifery. Inexcusable neglect and inefficient and careless administration of the well-known rules and recognized appliances of obstetric antisepsis must, in view of their admitted value, be regarded as criminal. The nurse as well as the medical attendant must be animated by the highest sense of personal responsibility, that wanton neglect or lack of diligence may not yield results fatal to the mother and deservedly injurious to their reputations.

*Attention to Details.*—The narration of the foregoing details may seem superfluous to the experienced practitioner, but the proper conduct of natural labor so clearly requires their vigilant and faithful execution, and their value has been so fully demonstrated by common experience and scientific investigation, that no apology is needed in a work of this character for their repetition. In fact, it is fully justified by the too frequent omissions and bungling methods of execution of many who undertake the service of the accoucheur only to display inexcusable ignorance and disregard of life. The minimum mortality of childbearing cannot be reached and maintained until the enforcement of the laws of hygiene and antisepsis has become universal among obstetricians.

The following discussion of the management of labor will be based upon the assumption that the head is presenting in the left occipito-anterior position, well flexed, in a normal pelvis, with a dilatable os and perineal and vulvar orifices; that the pains are regular and persistent, with gradually increasing intensity; that we have a docile patient with a good *morale;* and that the necessary appurtenances of a proper lying-in chamber have been provided.

## MANAGEMENT OF THE FIRST STAGE OF LABOR.

Ordinarily, there is not much for the physician to do during this stage, and his presence is not necessary except at proper intervals. The examinations should not be repeated oftener than necessary to ascertain the progress of dilatation. Frequent manipulation is not only useless, but sometimes injurious, and very apt to excite unpleasant suspicions on the part of the patient. If the rectum is clogged with fecal masses an enema should be administered. The patient should not be confined to the bed, but encouraged to sit up, walk about the room, and occupy herself in some agreeable diversion. The bladder should be frequently evacuated by voluntary effort, but in cases of retention either a silver or flexible catheter—whichever can be introduced with most ease and least discomfort to the patient—should be employed. She should be encouraged to let the pains pass, come, and go without any straining or bearing-down effort. Usually but little food is taken, but it may be advisable to insist that some simple aliment be taken in moderate quantities at reasonable intervals to prevent exhaustion. Drinking-water should be allowed at pleasure.

As the end of this stage approaches, which is usually indicated by the character of the pains, size and protrusion of the bag of waters, extent of dilatation of the os, and tension of the lower uterine segment, the patient should be put to bed and her clothing so arranged as to be protected from soiling by the discharges.

As a rule, the membranes will rupture spontaneously during the acme of a pain, marked by an audible gush of fluid and a simultaneous call of the patient for the nurse. As much as possible of the discharged fluid should be immediately removed by the employment of one of the large sponges in readiness for the purpose: indeed, when anticipating the rupture, it will often be convenient and add much to the comfort of the patient to have the nurse in proper position ready to protect the bed and clothing and make the patient as dry as possible. When the sac is persistent and causing delay in the progress of delivery, artificial puncture is advisable, and may, in some cases, be imperative. It may be accomplished by a prick with a hairpin, toothpick, or sharpened finger-nail gently thrust against the most dependent part of the bag of waters during a pain. A long or voluminous sac will require but little care, but a small, tense sac demands both care and gentleness or injury may be inflicted on the scalp. With the discharge of fluid Nature pauses in her efforts, to resume with renewed vigor during the stage of expulsion.

### MANAGEMENT OF THE SECOND STAGE OF LABOR.

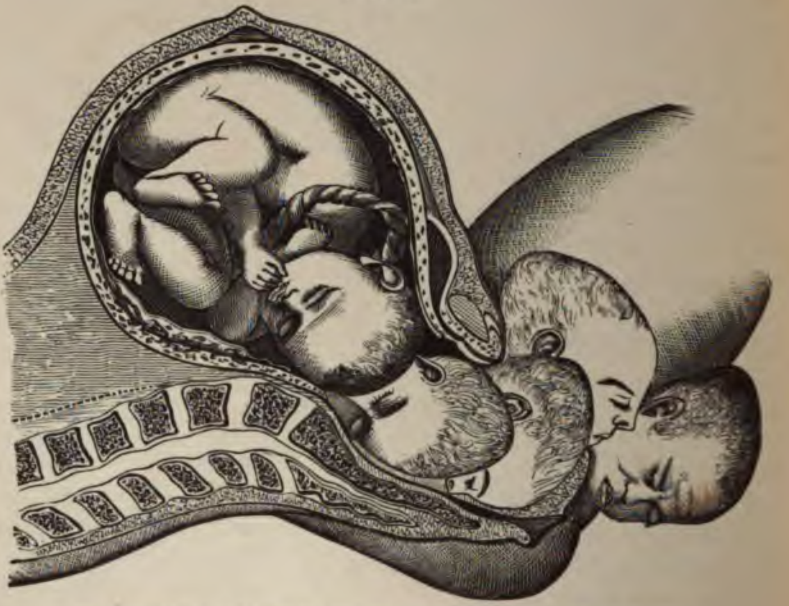
The second stage of labor requires the presence and constant attention of the accoucheur, and the patient should be required to remain in bed. The desire to pass water and evacuate the bowels should be relieved by the use of the bed-pan. Getting upon the commode has sometimes led to very surprising and injurious results, such as the unexpected discharge of the fœtus, attended with serious laceration of the perineum. Hot and cold water, ice, the ligature and scissors, and ergot should be in readiness for use. The presence of persons other than those actually needed as assistants should not be permitted. Sympathizing women and affectionate friends and relatives are bad companions for a woman in labor and troublesome interrogators to a truthful and conscientious obstetrician. The position of the patient in bed may be left to her selection. The physician should accustom himself to either the dorsal or left lateral posture, and to the use of either hand in making a vaginal examination. But during the later period of this stage the left lateral position is most desirable and convenient, and will quite frequently expedite the expulsion of the fœtus. It affords greater facility for such proper and neat attention as the vaginal and rectal discharges may require, and also permits inspection of the stretching of the perineum and dilatation of the vulvar orifice.

During the pain succeeding the discharge of the waters an examination should be made to verify the diagnosis of left occipito-anterior position and flexibility of the head, and to ascertain the condition of flexion, progress of descent and impulse and recession of the head, and to measure the effect of the uterine contractions. The examinations may be made sufficiently often to follow closely the progress of expulsion, but meddlesome interference should be avoided. As the labor proceeds the posterior fontanelle will be easily distinguished, and the caput succedaneum will gradually form, to a greater or less extent, upon the posterior and superior angle of the right parietal bone.

The conduct of labor is so commonly associated with presentation of the vertex in left occipito-anterior position that a brief description of the process of labor in this connection is necessary. The mechanism of labor in this position of the head is marked by certain clearly-defined acts by which its progress must be studied.

Descent and flexion are not synonymous terms. They are synchronous acts. The head enters the pelvis in the axis of the brim, and as it encounters resistance the occiput descends and flexion takes place, increasing with descent until the chin rests against the chest. When the head reaches the perineal floor the movement of rotation occurs, which brings the occiput under the arch of the pubis. As the head passes through the inferior strait, and sometimes even before, extension begins, and is completed with its extrusion through the vulvar orifice. Extension commences with engagement of the head in the inferior strait, and as it proceeds the sagittal suture glides along the distending perineum and the vulvar orifice expands, exposing a continuously increasing area of the occiput to observation immediately under the arch of the pubis. When the forehead has passed the coccyx, retraction of the perineum begins, and as it recedes over the face the occiput is thrust forward and upward over the pubis. As soon as this is accomplished the head is delivered and the movement of restitution takes place, whereby the occiput is rotated toward the side along which it descended in the passage of the head through the pelvis. This change in position of the head is effected mainly by the rotation of the

FIG. 213.

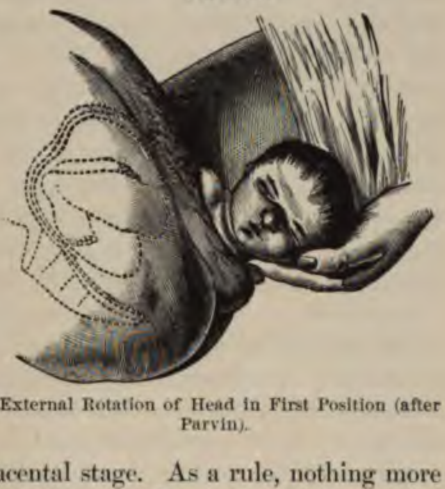


The Mechanism of Labor in Occipito-anterior Deliveries (after Schultze).

shoulders under the arch of the pubis, and partially by release of the torsion of the neck produced by the previous rotation of the head. As soon as the head is delivered the cord, if coiled around the neck, should be released by traction upon the placental end, so that it may glide over the shoulders, or the loop may be slipped over the head. In the rare cases in which it is coiled several times around the neck great care and gentleness are necessary. In some cases it may be necessary to apply a ligature and cut the cord. It should be cut between the ligature and the placenta, and delivery should be hastened by pressure upon the fundus of the uterus and gentle traction upon the fœtus.

THE DELIVERY OF THE SHOULDERS.—When the head has emerged from the vulvar orifice, one hand should be in position to support and hold it, as shown in Fig. 214, until the trunk has been delivered. The other hand should be employed in compressing the uterus and following it down with firm and even pressure. This downward pressure should be made during the contractions, but the hand should be held firmly in position during the intervals, and when removed to enable the accoucheur to give the necessary attention to the delivered child, it should be replaced by the hand of the nurse, who should keep up continuous but not rough pressure until he can resume complete management during the placental stage. As a rule, nothing more is needed to complete the delivery of the shoulders and trunk, but if the contractions of the uterus should be slow and feeble and the bearing-down efforts of the patient ineffective, contractions may be excited by friction with the hand over the uterus, and the patient may be instructed to hold her breath during the pains and reinforce the uterine contractions by pressing downward as if at stool. If the anterior shoulder should be caught by the arch of the pubis, it may be liberated by moving the head backward and then reversing the motion to deliver the posterior shoulder. In some cases it may be necessary to make gentle traction by grasping the head with both hands or by inserting a finger or blunt hook under the perineal shoulder, and, if failing then to complete delivery without too much traction upon the head, traction may be made from both axillæ. Such expedients are not often necessary, but

FIG. 214.



External Rotation of Head in First Position (after Parvin).

if delay is protracted and the life of the child is endangered, manual interference may become imperative.

As soon as the head is delivered and the neck liberated from the coiled funis, if the cord be around the neck, or not later than immediately after the delivery of the placenta, a drachm of the fluid extract of ergot, diluted with water, should be administered. The routine administration of ergot at this stage of labor is approved and practised by many, if not a majority, of the most experienced and successful obstetricians, because it secures firm and persistent contraction of the uterus, lessens the danger of post-partum hemorrhage, protects, in some measure, the patient from septic complications, and promotes involution, whilst the dangers, if any, of producing hour-glass contraction of the uterus are too remote for consideration.

After the extrusion of the shoulders the birth of the child is usually speedily effected. If any delay should occur, the delivery of the remaining part should be expedited by traction upon the trunk. The completion of the birth is usually announced by vigorous crying of the infant.

ATTENTION TO THE CHILD.—As soon as the child is born it should be removed, but not far enough to make traction upon the cord. If necessary to facilitate respiration, any secretions should be removed from the nose and mouth with a finger covered with some soft material. Respiration may be promoted by sprinkling cold water in the face, friction of the chest, slapping the buttocks, tickling of the fauces with a feather, or momentary inhalation of ammonia, or artificial respiration.

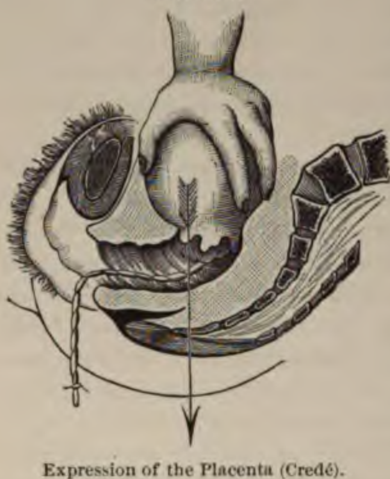
LIGATION OF THE CORD.—Notwithstanding occasional attempts to deride the ligation of the cord and to prove its uselessness and injury, it continues to be practised by every careful obstetrician, not because it is necessary in every case, but because no one can tell when it is not necessary. As a rule, the ligature should not be tightened until the pulsations in the cord have ceased, for it has been proven that immediate ligation deprives the infant of an amount of blood which is injurious. But it is not prudent to delay ligation beyond a reasonable period, say fifteen minutes. The cord should be stripped for several inches from the umbilicus by gently pressing along its continuity with the thumb and index finger, to displace, as far as practicable, the gelatinous material, and about two inches from the abdominal surface the ligature should be placed and firmly tied without cutting the tissues. The ligature may be either narrow bobbin or silken or hempen cord, sufficiently strong, but not fine enough to cut the cord. A second ligature should be placed two inches distant to secure the placental end. The second ligature may not be necessary, but is always judicious, and is believed by some to promote the detachment of the placenta, because of the retention of the blood and consequent increased bulk. In cases of multiple pregnancy there may exist vascular connection between the fœtuses.

After having placed and securely tied the ligatures, the cord should be severed midway between them with a pair of blunt-pointed scissors, care being taken not to injure the fingers or toes of the child, which are apt to be in the way. The cut surface of the fœtal end should be wiped dry with a cloth or cotton wool to discover any hemorrhage, and when satisfied of security against bleeding, and not till then, the child should be carefully removed, wrapped in a warmed blanket, and laid on its side in some safe place where it can be kept warm and free from injury until it can be washed and dressed. Caution suggests occasional inspection of the cord, and if there is any sign of oozing of blood another ligature should be applied.

DELIVERY OF THE PLACENTA.—The concluding stage of labor demands immediate attention after the separation and removal of the infant. If the process of extrusion of the fœtus has been followed by firm and equable downward pressure over the uterus during the later moments of the expulsive stage, and firm and continuous pressure has been maintained during the succeeding interval whilst attention is being given to the ligation and cutting of the cord, the placenta will, most usually, be found partially or wholly expelled from the uterus and lodged in the vagina, from which it can be withdrawn by gentle traction upon or prolonged tension of the cord, or, better, by hooking the mass with a finger, care being taken not to tear the cord from its placental attachment or to injure the substance of the placenta. Whilst it is being thus extracted it should be supported by the left hand, so that undue dragging upon the membranes may be avoided and their extraction may be accomplished without leaving any fragments in the uterus. The secundines are so very fragile and easily torn by rough and hasty handling that great care and gentleness is necessary to secure their complete delivery. A vessel should be in readiness, and so placed, closely to and beneath the vulvar orifice, as to receive the placenta, blood-clots, and fluid without unnecessary soiling of the clothing and bed. Twisting of the membranes during their withdrawal is not necessary, nor can it conveniently be done with a vessel properly placed.

If the placenta cannot be so easily delivered, it should be expressed by the method of Crede, which consists in gentle friction with the hand applied over the fundus of the uterus, and during a contraction by a firm downward pressure with the palm of the hand smoothly applied over the fundus, the fingers extending over the posterior and the thumb over the anterior surface. This manipulation may be repeated if necessary until the placenta and all blood-clots are squeezed out of the uterus and the organ is secure in the state of firm and persistent contraction. The hand should be held in position grasping the uterus, as above described, during the delivery of the placenta, by moderate not always strong pressure, until complete contraction is assured and maintained; but only when necessary to reinforce the spontaneous efforts should friction and force be employed. Ordinarily, the employment of the hand is simply cautionary to detect and prevent relaxation and consequent hemorrhage. Having completed the extraction of the placenta and secundines, and secured firm contraction of the uterus, the patient should be cleansed by washing off all blood-stains from her person and removal of soiled clothing, pads, and bed-linen preparatory to the adjustment of the binder. The external genitalia should be dressed with great tenderness to avoid giving pain. A warm disinfecting fluid should be used for this purpose, and a wash-rag of some soft material is preferable to even the finest sponge, because it is less irritating to the sore and tender parts. The hand over the uterus should be held in position until the binder is applied, or at least very frequent examinations should be made to discover any symptom of, or actual, relaxation and hemorrhage. Every precaution, however trivial it may seem and tedious it may be, may be necessary at this critical period to protect the patient from the spoliative and dangerous complications of post-partum hemorrhage. Until the uterus is firmly contracted, the binder properly adjusted, and the patient comfortably arranged in bed, no woman can be considered safe, and no practitioner is justifiable in omitting any precautionary measure to prevent the occurrence of such a destructive complication.

FIG. 215.



Expression of the Placenta (Credé).

The vulva and perineum should be carefully inspected. If the perineum has sustained injury by tears beyond the parting of the fold of mucous membrane known as the fourchette, one or more sutures may be necessary, and if so should be introduced at once. Immediate perineorraphy is commended to the careful consideration of every judicious obstetrician. Trivial tears or injuries of the vulva or perineum may be dressed with some disinfecting application; dusting with iodoform is usually all that is needed.

APPLICATION OF THE BINDER.—The good effects claimed for the binder, when properly adjusted and fastened, are the preservation of the figure, compression of the abdomen, restoration of intra-abdominal pressure, compression and fixation of the uterus, prevention of relaxation of the uterus and consequent hemorrhage, and promotion of involution. It should be made with gores, to be easily and smoothly applied, so that it will remain in position and not slip away from its proper adjustment and become an annoyance, increasing the discomfort rather than adding to the ease of the patient. If one has not been prepared, a crash towel or a piece of cotton cloth may be used. It should be rolled on itself from one end to its middle, and the roll should be carried under the back of the patient to the opposite side, then unrolled and smoothly applied, extending from the chest downward below the symphysis pubis and over the hips. A pad made of a folded towel or any convenient and clean material should be placed over the fundus of the uterus, and the bandage drawn tightly and secured with safety pins, beginning at the lower margin and placed sufficiently close to secure smoothness and equable pressure.

The final act of placental delivery having been accomplished, the patient should be comfortably arranged in bed, with sufficient bed-clothing to maintain warmth, and allowed to rest quietly. A soft antiseptic pad should be applied to the vulva, and a clean folded sheet laid beneath her to protect the underlying bed-clothing from being soiled.

In applying the binder care should be taken not to expose unnecessarily the person of the patient. The modesty of women does not forsake them even under such trying circumstances. A clean warmed towel may be used to conceal the genital organs while the binder is being adjusted, and removed when it is properly placed.

DRESSING THE CHILD.—The necessary attention to the mother having been fully and completely discharged and her rest and repose having been secured, the child should be washed and dressed. This is usually done by the nurse, but should be done in the presence and under the supervision of the accoucheur. A vessel of clean warm water, a soft sponge, a piece of old, well-used cotton cloth, some vaseline, sweet oil, or other innocuous oily substance, and a piece of castile or other good soap, should be in readiness. The scalp and body of the child should be gently rubbed with the oily substance to facilitate the removal of the vernix caseosa, care being taken to clean the folds and joint-flexures, and they should then be wiped dry. The face should be washed with clean water without soap to avoid irritating the eyes, and dried with a clean soft cloth. Washing the child should be done gently, quickly, and dextrously in a warm room, without unnecessary or prolonged exposure. If, as is occasionally the case, the vernix caseosa cannot be removed without rough or too prolonged handling, or the infant is too feeble to be subjected to the necessary rubbing, its thorough and complete removal may be left until the next day. After washing the infant the cord should be dressed. Various methods of dressing the cord have been suggested and practised with equal success. Some use a square piece of soft linen or muslin, with a hole in its centre through which the cord is drawn; sometimes it is smeared with simple cerate or other equally objectionable fatty or oily substance; and by others it is slightly scorched. The linen should be smoothly folded around the cord. Some simply express the gelatinous substance from the cord and leave it without any dressing; others surround the cord with absorbent cotton; and others sprinkle it with iodoform or salicylic acid and wrap it with a few turns of a narrow bandage. A simple plan is to take a narrow piece of very soft linen or muslin three or four times as long as the cord, slightly notched at one end to fit neatly around the base of the cord. Adjust the notch and fold the cloth laterally upon itself over the cord and throughout its length; then fold it lengthwise along the cord on the side to be laid against the abdomen of the infant, and by reversing the fold, carrying it over the cut end and along the upper side, the cord will be enveloped smoothly and completely. No other dressing is necessary, and the cord and dressing will fall off together on the fourth or fifth day.

The cord, either dressed or stripped as the case may be, should be laid longitudinally and evenly on the abdomen, and the "belly-band," made of soft flannel, applied. This should be done with great care—not too tightly—and it should then be fastened with a few safety pins so arranged as not to injure or irritate the infant. The clothing should fit neatly, but loosely. Pins should never be used; tapes are preferable.

During the time occupied in washing and dressing the infant the accoucheur should examine the condition of the patient. The pulse, respiration, and condition of the uterus demand special attention. If there is any suspicion of relaxation of, or accumulation of clotted blood in, the uterus, it should be compressed firmly after the method of Credé, to restore contraction and squeeze out the clots. This may be repeated as often as is necessary. The physician should not leave the patient within the first hour of her puerperium, and not then without giving directions in regard to feeding the mother and nursing the infant. As a rule, the child should be put to the breast within the first two hours after its birth, and the mother should have some bland liquid food not later than three hours after the completion of her labor, unless sleeping, and then upon waking.

In cases of multiparæ it is always advisable to leave with the nurse directions with regard to the management of after-pains, but narcotics will rarely be necessary if care be taken to expel all blood-clots from the uterus before leaving.

The conduct of labor is modified in many of the minor details by the employment of an anæsthetic. The foregoing history of the conduct of natural labor has been written upon the basis that none has been used, but this course is not advised by the writer. Anæsthesia in obstetrics is second only to antisepsis. The discussion of the subject of obstetric anæsthesia belongs to another place, but the writer desires to conclude the description of the conduct of labor with the definite expression of his unqualified approval of the judicious use of anæsthetics in labor.

## THE CARE OF THE PERINEUM IN NATURAL LABOR.

Much has been written in regard to the necessary care of the perineum during the passage of the head through the vulvar orifice, and many methods of preservation have been devised and recommended by obstetricians. Every method has its advocates, and every case in which any method is applied without the occurrence of rupture is offered as proof of its protective value. This enthusiastic advocacy is based upon a fallacy which may as well be admitted and plainly stated. Lacerations of the perineum have probably occurred from the beginning, and will continue to occur to the end, of childbearing, notwithstanding the employment of methods of prevention however well devised and carefully applied by the most skilful obstetricians. The escape of a perineum from rupture is no more proof of the protective value of the method employed than rupture is proof that its application was conducive to the injury in the case in which it occurred. It is quite as reasonable to assume that the elastic tension and expansile property of the soft parts were equal to the occasion as that support of the perineum facilitated the exit of the head through an orifice too small to admit its passage. The frequency of laceration, like other accidents of parturition, varies in the practice of equally skilful and careful accoucheurs, whether or not they employ the same methods or vary them. The inventor of a new device will herald his success, and another practitioner, equally conscientious, skilful, and watchful, will, after a fair trial, abandon it because of its utter worthlessness. The fact is, that in the former instance no more lacerations would have occurred if any other, or probably no, method had been employed, and in the latter an equal number would have occurred if any other method had been practised. One ascribes his success to good and the other his failure to bad management, when, in fact, it was the same in both classes of cases and did not affect the result in either class. The lacerations were unavoidable, and one obstetrician was more unfortunate than the other in having more of such cases than the other.

It is not, however, denied that lacerations of the perineum may be prevented or limited, and it is asserted with even more emphasis that labor may be completed without parting of the fourchette. It is furthermore maintained that perineal tears do not always begin in the mucous surface. The writer has on several occasions watched the process in primiparæ fully anæsthetized and entirely incapable of voluntary effort. In such cases when the parietal eminences were embraced by the thinned and tense rim of the vulvar orifice the tear has begun in the external layer of the integument, about one inch behind the margin of the commissure, and expanded into a circle, leaving the mucous membrane entire. With the succeeding and last contraction of the uterus the mucous membrane yielded, and the tear extended forward with the escape of the head. This has been the history of several cases of rupture occurring in primiparæ in which he has had the opportunity of carefully watching the process, with the patient in the left lateral posture, notwithstanding the employment of methods of prevention by manual interference.

Lacerations usually extend along the median line of the perineum, and may involve the sphincter ani muscle and recto-vaginal septum. In rare cases central perforation takes place and the head is thrust through the tear. In some cases the mucous membrane is torn without involving the skin. But few primiparæ escape tearing of the fourchette.

Tears begin in the tissue and at the point where the elasticity and resistance are the least or where the force is the greatest. The frænulum is the thinnest, weakest, and most attenuated part of the expanded and tense rim of the orifice. In occipito-anterior positions it quite often, if not most frequently, begins at the acme of a pain with the escape of the brows, and extends backward in the median line until the tension is relieved. If the pain and propulsion of the head are continuous, the laceration will be more extensive. Rupture occurs less often in anterior than in posterior positions of the occiput, the tension of the frænulum being less because the space beneath the arch of the pubes is more available.

Laceration is not necessarily nor always an unfortunate injury. It is sometimes preferable to long-continued stretching and bruising of the soft parts. In rare cases sloughing has followed the bruising and crushing of the tissues by persistent pressure and stretching, and every operator has secured better results in immediate perineorrhaphy in cases where the tear occurred early than in those in which it took place after prolonged distension and bruising.

The frequency of lacerations is approximately stated to vary in primiparæ from 20 to 30 per cent., and in multiparæ from 5 to 1[illegible] per cent. Of these, 15 per cent. are estimated to be due to defective expansibility of the perineum and the size of the head. The most reliable statistics, collated from the clinic at Halle as the result of ten years' observation of preventive measures, rate the lacerations in primiparæ at 21.1, and in multiparæ at 4.7 per cent. These statistics refer to tears extending beyond the commissure. The classification into avoidable and unavoidable is based upon limitations which place the unavoidable class far below its actual rate of occurrence. The only logical conclusion to be drawn from ten years' careful and expert employment of preventive measures in a large obstetric clinic is that the percentage of perineal ruptures establishes the ratio of frequency of unavoidable lacerations, and that the avoidable are as near *nil* as science, art, and skilful interference can make them. If these figures and statistics prove anything, this is the inevitable conclusion, and they clearly show the futility of methods of prevention. Such conditions as threaten laceration may appear to, and yet may not, exist, for there is no method of measuring the expansibility of the perineal structures, elasticity of the vulvar orifice, or excess of propulsive power, except by the absence or occurrence of rupture. Hence the statistical argument in favor of perineal support is fallacious, because it is based upon a mistaken diagnosis and an unavoidable result.

In estimating the frequency, the age at first labor, the condition of the perineal structures and of the patient, and the circumstances of labor should be considered. Primiparity at suitable ages is less frequently a cause than primiparity at advanced age, and the farther advanced the age the greater the liability. The great difference between the estimated ratios of frequency in primiparæ and multiparæ proves conclusively that the injury is most often due either to some condition of primiparity or to the position and size of the fœtal head; and the rarity of occurrence in multiparæ shows even more clearly either that rupture had occurred during a first labor, or, occurring in a later one, was occasioned by some anomalous condition peculiar to the case, which classes it among the unavoidable injuries of parturition.

The various causes of perineal laceration may be concisely stated as follows: Unfavorable position and size of the head; too rapid extension in occipito-anterior and insufficient flexion in occipito-posterior positions; precipitous expulsion; injudicious voluntary efforts; acuteness of subpubic angle; rigidity, thickness, diminished expansile property, and too rapid retraction of the perineum; slow or insufficient dilatation of the vulvar orifice; conditions of the perineal tissue due to improper development and previous disease; awkward handling and injudicious and hasty traction in forceps cases, as also failure to remove them when the obstacle to delivery has been overcome, or to antagonize the expulsive forces at the proper moment when the head can be firmly held *in situ* by the grasp of the instrument, thus affording time for full development of the elastic power of the perineal structures; and the improper use of ergot or other oxytocics. Hasty traction or precipitous expulsion of the shoulders may also be enumerated among the causes. In some cases the tense and thinned margin of the commissure is nipped by the nose, and the tear thus begun is caught and extended by the passage of the chin.

A glance at the foregoing array of causes ought to convince the most enthusiastic advocate of manual prevention that when the cases of laceration due to natural causes beyond the control of art, and to improper interference with the normal course of labor, are eliminated, comparatively few will remain to afford opportunity for the exhibition of skill in prevention. It must be equally clear that measures directed to the support of the perineum without removal or arrest of the cause must prove ineffective. If the vulvar orifice is too small to permit the passage of the head, or if the expansile property of the perineal tissues is insufficient to allow ample stretching, or if their tensile strength is less than the expulsive power of the expellent forces, rupture is inevitable. In such cases mere support of the tense and thinned tissues either by the application of the hand or adjustment of a bandage must be futile.

The proper care of the perineum consists, then, in omitting the interferences that are believed to cause injury. Omit the improper use of ergot and all manipulations which excite the reflex forces; suspend the injudicious voluntary efforts; correct the defects of flexion and extension; diminish the expulsive power of the uterine and abdominal contractions; arrest the advance of the head and slow its exit, so that the attenuated perineum will gradually retract and glide over the irregularities of the face without tearing beyond the commissure; and prolong the perineal stage. These suggestions refer to the removal, lessening, and arrest of the cause, and not to the propping up of an attenuated and fragile tissue, whilst the forces or causes are continuously operating with probably increasing intensity. The acts of omission are quite as important as the acts of commission.

Obstetric narcosis and the forceps subserve the purposes of delay and antagonism far more effectively than manual resistance or perineal support. Narcosis, though not often necessary or prudent, may be pushed to complete arrest of the progress of expulsion. It should not, however, be carried to that degree. The object should not be to suspend labor, but to lessen the force of the uterine and reflex forces so that full development of perineal and vulvar dilatation may be attained. The same may be accomplished, but to a less degree, by the employment of the forceps. As a rule, however, the progress of propulsion in such cases is too precipitous to afford time for their adjustment; but in cases where they may have been previously applied the operator, by the exercise of a moderate force of resistance, can slow the exit of the head. The conjoint employment of narcosis and the forceps is more effective than either separately, because the force is lessened and the resistance to propulsion is increased. If by either one both conjointly the intermittent character of the utero-abdominal contractions can be maintained or re-established, a favorable result will be more probable. A less effective but more popular method consists in slowing the escape of the head by pressure with the thumb against the occiput, whilst with the fingers applied near the border of the commissure rotation under the arch of the pubis is promoted. This is merely employment for one hand, unless aided by control of the accessory forces; and when such aid is effective the hand-power is nugatory, except so far as it may effect rotation; and this may be more easily and certainly accomplished by inserting a finger through the rectum in the mouth or under the chin of the child. By this latter manipulation the head may sometimes be held in position, or rather recession during the interval may be partially arrested, so that continuous moderate pressure is maintained against a dilatable orifice. Lusk asserts that he has accomplished delivery of the head and avoided rupture by imitating during the intervals the intermittent character of the pains, by establishing a to-and-fro movement of the head with a finger under the chin of the child.

Shelling-out processes, which refer to delivery of the head during the intermission of contractions, are based upon the hypothesis that a head which cannot pass an elastic orifice at its maximum dilatation will roll out of its own volition, or that the orifice can be slipped over the head when its property of expansion is at its least tension. An orifice that can be stretched over a head in recession will not tear when stretched by the wedge-like pressure of the head against it.

These digital manœuvres have been modified by combining occipital and rectal pressure. The head is grasped by the hand with the thumb inserted far into the rectum and the fingers over the occiput. By this fore-and-aft grasp the head may be held and progression and extension may be partially controlled. Its effectiveness will vary greatly with the relative size of the head and hand. A large hand with a small head will do very effective work, but a small hand with a large head will not accomplish much. A head propelled by a fifty-pound pressure will not tarry long in such a grasp. Apart from the inutility of rectal expression, direct injury may be inflicted upon the gut by rough and too long-continued pressure. Æsthetic considerations should never exclude an effort that promises a beneficial result, but the introduction of a finger into the rectum is always repugnant to a female.

Perineal relaxation has been advised by two very distinguished obstetricians. Playfair's method consists in forward pressure made along the sides of a distended perineum with the thumb and fore finger, whilst with the tips of the other fingers applied to the vertex the exit of the head is retarded. Goodell's method is executed by drawing the perineum forward with the fingers hooked into the rectum and slowing the advance of the head by pressure with the thumb. This is an artificial effort to increase the stretching of the anus, which always takes place, and is not unreasonable; but, like some other measures, it is applied at the wrong end. It is not anal stretching, but dilatation of the orifice, that is most needed. The possibility of exciting reflex movements by these manipulations is an objection to their employment. More harm may be done than good accomplished. The equable pressure of the advancing head is a much more effective force to develop the expansile property of the tissues than digital stretching during the intermissions, which cannot be applied uniformly to the distending surface.

The methods of direct support to the perineum consist in the application of the hand or a bandage. The hand may be applied with the palm resting against the bulging part and fingers toward the orifice, or the position of the hand may be reversed. In either case, pressure should only be made during the pains in such manner as to favor extension or flexion as the position of the occiput may be anterior or posterior, and to promote rotation of the head under the arch of the pubes. The preferable position of the hand is with the fingers toward the orifice, that pressure may be made with the tips along the margin of the tense rim. A better method than either of these is to pass the left arm between the thighs, the patient lying in the left lateral posture, and grasp the perineum with the palm against the convex part of the most distended part. By this method the operator may exercise very considerable force.

Reamy and Price have suggested the application of a bandage. Reamy[1] places the patient "on her back across the bed, with nates brought to its verge." "The thighs are flexed over the abdomen, and legs upon the thighs, with the knees brought close together." "Two assistants are given opposite ends of a towel or a bandage of linen about ten inches wide and forty to fifty inches long, which is carried around the buttocks and spread out smoothly with its anterior or upper edge on a level with the fourchette. They are then instructed to make traction during the pains in such amount, in such direction, and with such part of the bandage as the accoucheur may direct."

Price[2] seeks to crowd the surrounding tissues in the direction of t vulvar outlet by a bandage applied over the pubes and trochanters a fastened over a firm pad resting against the coccyx and anal orifi By this method he claims that relaxation is secured and the head pressed toward the pubic arch.

Laceration of the cervix uteri to a greater or less extent is not l frequent than tearing of the perineum, yet the conditions of cervi

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[1] *Obst. Trans.*, vol. x. p. 153.

[2] *Trans. Med. Soc. Pa.*, 1884.

dilatation are less conducive to injury than those of perineal dilatation. The lower segment of the uterus is more uniformly distended; the descent and direct pressure of the head are graduated by the interposition of a fluid; the os is dilated by the protrusion of the bag of waters; force is more evenly distributed and pressure is less influenced by unfavorable positions of the occiput; whereas the perineum is an elastic structure guarding the pelvic outlet, so arranged and unprotected that it must receive the impulse of the force of propulsion whilst the head is rotating under an immovable and bony archway. The force is quite as great, if not greater, and certainly more continuous, after the biparietal diameter has passed the inferior strait and the head enters the vulvo-vaginal canal, capped in front by an unyielding arch and covered posteriorly and laterally by expansile tissues which receive the brunt of the force of propulsion. The fact that in both instances the laceration begins far most frequently at the margin of the orifices, notwithstanding the tension and attenuation of the lower segment of the uterus in one and of the perineum in the other case, proves conclusively either that such margin is the point of least resistance or greatest force, and that in both cases orificial dilatation is insufficient to admit the passage of the head.

Perineal support will, however, continue in the future, as it has in the past, to command the attention of obstetricians, and methods will be tried, however useless they may be proven to be. The desire to be employed will always invoke effort, and the hope of contributing something to lessen the agony of childbearing will always animate sympathizing and impressible obstetricians.

EPISIOTOMY.—To prevent serious laceration of the perineum some have advised that one or more lateral incisions be made with a pair of blunt-pointed scissors or a probe-pointed bistoury. If one is not sufficient, another may be made on the opposite side. The operation is not often practised, and has not received the support of obstetricians.

### RESUSCITATION OF ASPHYXIATED INFANTS.

Asphyxia neonatorum occurs in two forms—the anæmic and the apoplectic. In the former the infant is pale and limp, with cold surface and flaccid muscles. The conjunctivæ are bloodless; the mouth is open, with lower jaw hanging; and the sphincters are relaxed. The heart-beats are very feeble and frequent, sometimes not perceptible. Pulsation in the umbilical cord may be absent. Respiration is either suspended or jerking, shallow, gasping, and at long intervals. Sometimes only a slight recession of the lateral chest-walls at long intervals can be seen or felt. The apoplectic form is characterized by congestion of the surface, most marked about the head and face, and varying in color from a deep red to a purple. The lips are swollen and red, the conjunctivæ are injected, and the eyeballs protrude. The muscles are not rigid, but there are not the flaccidity and relaxation present in the anæmic form. The heart-beats are slow, but labored, strong, and full, and the umbilical vessels are distended with blood. Reflex movements may be excited. Respiration is slow and feeble at first, but gradually increases in frequency and fulness, and soon, with proper and timely treatment, is followed by audible cries. Sometimes the cry is preceded by contortions of the face, like an inaudible effort at crying.

The anæmic form may be caused by insufficient nourishment, torsion, prolapse, or compression of the cord, diseases of the placenta, disturbances of the placental circulation, feeble development, congenital disease and malformation of the infant, premature labor, excessive high temperature, or poisoning of the mother by morphia or chloral. The apoplectic form is usually the result of tedious labor, especially a prolonged second stage after too early discharge of the liquor amnii, continuous uterine contractions induced by ergot, breech presentations, and compression by the forceps. In the anæmic there is insufficient blood-supply; in the apoplectic there are local congestions and general venous excess.

In some cases the asphyxia is so profound that the evidences of life are inappreciable, and cases are reported where infants have been reported dead and laid aside, to revive after considerable time had elapsed, much to the chagrin of the accoucheur, who had omitted making any effort or negligently performed some improvised method of resuscitation. It quite often happens in breech deliveries that animation is suspended, but with proper care vigorous life will soon be made manifest.

The prognosis is unfavorable, both as regards the efforts at resuscitation and the preservation of life afterward, but the success of those who have carefully and skilfully practised the methods of resuscitation has been sufficient to make it obligatory upon every obstetrician to exhaust the resources of science to restore and preserve the life of a stillborn child. The prognosis is less favorable when intra-uterine respiration has taken place, and even more unfavorable when aspiration of liquids and foreign material has occurred.

A diagnosis of the form of asphyxia should be made at once; in fact, in some cases it may be anticipated by a thoughtful consideration of the history of the labor. In such cases hot and cold water and a suitable elastic catheter may be in readiness for immediate use. In the anæmic form the cord should not be tied until the pulsations have ceased; in the apoplectic it should be cut and a drachm or two of blood allowed to escape, care being taken to secure the placental end with a ligature, and to hold the fœtal portion with the thumb and index finger, so as to arrest the flow of blood with the first full cry of the child.

If the ordinary expedients, before referred to, fail to excite respiration—and too much time must not be wasted in such efforts, for they are only of value in cases of delayed or slow respiration—artificial respiration must be established. To accomplish this the mouth and fauces must be cleared of any collection of mucus or other material with the finger wrapped with soft moist linen, and the aspirated fluids must be removed from the air-passages, either by mouth-to-mouth insufflation or by insufflation through a tube or catheter introduced into the larynx. The child's mouth should be wiped dry, and over it a clean towel should be placed; then the obstetrician, after a full inspiration, should apply his mouth and expire slowly and moderately, forcing the air into the child's mouth. Some may enter the large bronchi, but most will escape through the nostrils, thus clearing them of mucus. By gentle pressure with the hand over the sternum or lower latero-anterior region of the chest-walls of the infant expiration will be imitated. By repeating insufflation several times spontaneous inspiration may be excited. This method failing, a flexible catheter or tube may be introduced through the glottis by gently passing it downward behind the epiglottis. By this method the fluids in the lungs may be aspirated and insufflation may be effected. Respiration may be hastened by the simultaneous employment of cutaneous stimuli, such as frictions, flagellation, the application of the hand alternately dipped in hot and cold water, blowing in the face, rubbing the back, sprinkling water upon it, alternately bathing the infant in hot and cold water, or the effusion of the chest or neck with cold water while the body is immersed in warm water. If the infant "is thin, pale (Jacobi), and collapsed, a hot injection into the bowels (104°–108°) will render good service."

Artificial respiration may be established by one of the following procedures:

Byrd's method[1] is simple and easy of accomplishment. It is as follows: "Bring the ulnar sides of the hands together, with the palmar surfaces looking vertically, and prop them beneath the back of the infant, so that the extended thumbs may aid, as far as possible, in sustaining the vertex and inferior extremities; then, keeping the ulnar borders of the hands near together, so as to form a fulcrum, the radial borders or sides are simultaneously depressed to as great extent as practicable—say forty-five degrees—below the horizontal line, and then gradually elevated or pronated to as many degrees above that line, thus facilitating the escape of air drawn into the lungs during the downward movement of the head and chest." These movements should be performed in a regular and gentle manner, and repeated several times. If

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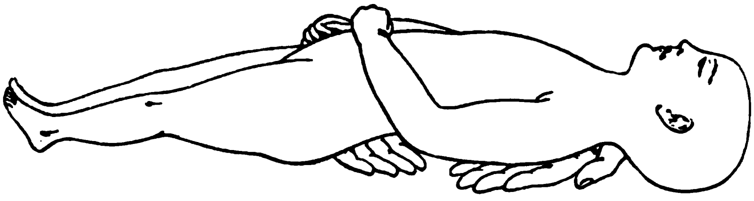
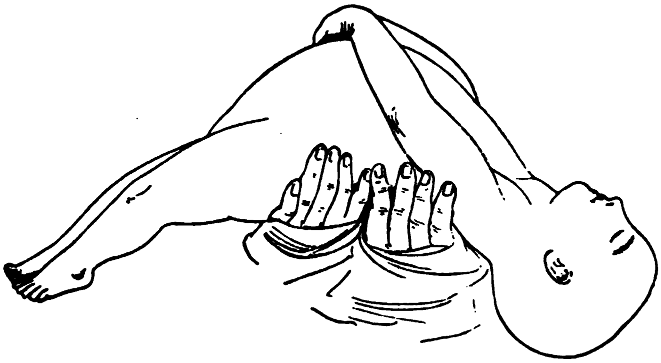
[1] *Obstet. Journ. Great Britain and Ireland*, Supplement, vol. i. p. 65.

FIG. 216.



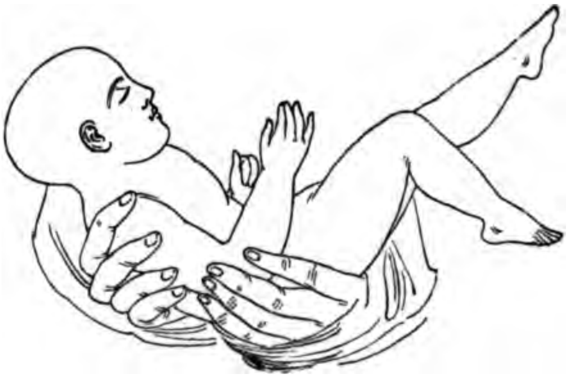
First Position.

FIG. 217.



Second Position.

FIG. 218.



Third Position.

necessary, as will usually be the case, the head should be held by an assistant.

Schultze's[1] method consists in attempts to produce alternate expansion and compression of the lungs by suspension and swinging of the infant. The child is grasped with both hands, with the thumbs resting against the thorax, an index finger in each axilla, and the fingers across the back. It is then suspended, with the face to the front, between the knees of the operator. In this manner elongation and stretching of the chest-walls are produced upward by the traction of the head, and at the base by the falling downward and backward of the lower extremities. The diaphragm is depressed. This elongation of the chest promotes inspiration. Then by swinging the child, by elevating the hands and arms forward above the horizontal line until the body is made to rest upon the thumbs, with the head flexed forward and lower extremities falling forward and downward, the chest is compressed and the aspirated fluid and air are expelled. By repeating these movements at brief intervals mechanical elongation and compression is kept up, which stimulates the movements of inspiration and expiration, and may establish spontaneous respiration. It should be continued until the breathing is full and complete.

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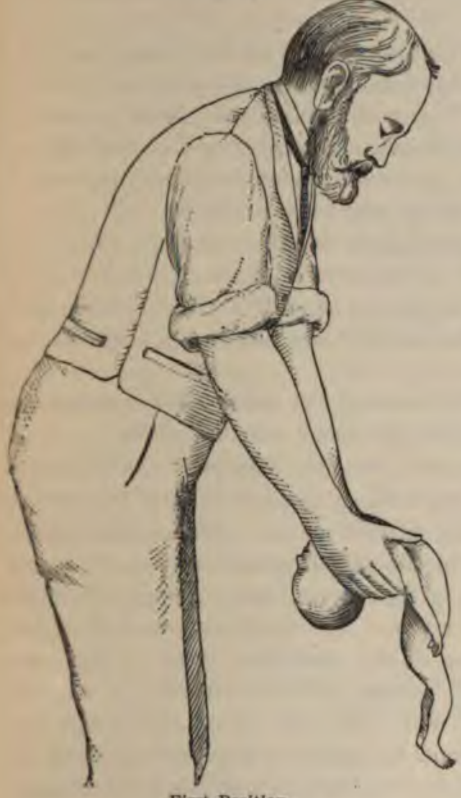
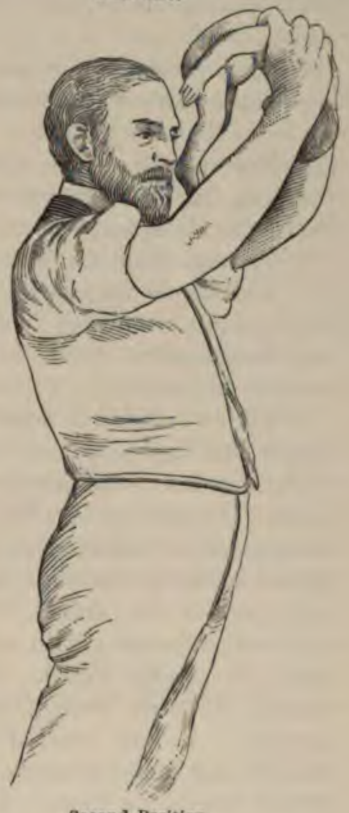
[1] *Der Scheintod Neugeborener*, Jena, 1871, p. 162.

FIG. 219.



First Position.

FIG. 220.



Second Position.

Sylvester's method is simpler than either of the others, and has proven satisfactory in very many cases. It is preferable in cases of very feeble infants, because it involves less exposure and manipulation. The child is warmly wrapped and laid upon its back with the head slightly raised. Then both arms are simultaneously and slowly raised toward and alongside of the head, and then replaced and pressed to the sides to expel the air from the lungs. These movements are repeated until spontaneous respiration takes place or further effort is considered useless.

Goodell promotes the entrance and exit of air by laying the child across his hand, with the head and arms hanging down on one side and the lower limbs on the other. Then with a quick movement he doubles the child up with its chin to its knees. By repeating this folding and unfolding of the child he has succeeded in establishing respiration. When the child gasps he suspends any further effort.

After respiration has been established by either of these procedures the child should be immersed in warm water, then wrapped warmly and kept in a room with the temperature above 70° Fahr. Stimulants may be necessary. It should be carefully watched and nourished until recovery is secure.

Wood resuscitated a child by drawing the entire cord between the thumb and fingers so as to force the blood into the child.

Faradization of the phrenic nerves has also been practised with good results. Jacobi says:[1] "The point of application is near the sterno-cleido-mastoid muscle, over the phrenic nerve. The other pole is applied either to the neck or to the diaphragmatic region or to any other part of the surface. It is best to use large sponge electrodes moistened thoroughly with salt water. The head, arms, and shoulders should be slightly raised. One of the electrodes must be kept stationary, the other brought into contact with the surface but a single moment. A deep inspiration will then take place, the lungs will expand, and lateral pressure must be made on the lower part of the chest to empty the lungs. Another application and the same manipulation must be made and repeated until the baby cries. When coughing occurs, it must be omitted. Continued or too frequent irritation by the current causes over-irritation and paralysis. If the inspirations, after appearing to be fully established, should become superficial, the pulse feeble, and the cyanotic hue return to the lips and finger-nails, some other method must be substituted. The child should be carefully watched for several hours after resuscitation, because the result is not always permanent, and it may be necessary to renew the applications."

The reported cases of resuscitation after the expiration of considerable time, exposure, and sometimes ill-usage of asphyxiated infants suggest the possibility of success under very inauspicious conditions.

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[1] *Archives of Pediatrics*, vol. v. p. 133.

In one case the child had been hidden in a sandpit for half an hour; another had been buried one foot under the surface of the ground for five hours; another was exhumed one hour after burial; another was saved after three-quarters of an hour's burial; and in one case life was discovered in a child twenty-three hours after it had been supposed to be dead and prepared for burial. However incredible these reports may be, they are, nevertheless, instructive, and may show that ill-usage and chilling are not without salutary effects, and may ultimately prove that more careful exposure and refrigeration may be a valuable method of resuscitation.

In this connection the cases recently reported by Goodell are of special interest. In one case the child revived after having been laid aside. The efforts at resuscitation had failed. In another case two physicians had pronounced the infant dead after the failure of several methods to induce respiration. The child was placed outside of the window on the roof, the night being cold. When taken in to be washed it was alive. A third child was laid in the corner of a room after failure of various methods of artificial respiration; an hour later the nurse took it to the bath-room to prepare it for burial and found it alive.

Some observers have claimed better results when the efforts at resuscitation were executed with the child laid naked on the bare floor in a room cooler than the lying-in chamber. The writer has in two apparently hopeless cases succeeded with Sylvester's method in this manner. In both cases the asphyxia was of the anæmic form. Both children are now alive, healthy, and robust.[1]

## THE PHYSIOLOGY AND MANAGEMENT OF PUERPERAL CONVALESCENCE.

The puerperal state comprises the period beginning with the completion of the third stage of labor and terminating with the recovery of the patient. During this period the convalescence from the traumata of labor takes place coincidently with the progress of certain retrogressive and developmental processes. The clinical history of the lying-in presents a combination of physiological and pathological phenomena which is necessary to complete the recovery of the woman from the conditions of pregnancy and injuries of parturition and to prepare the organism for the duties of maternity. Processes of waste and repair, of growth and development, are either called into existence or incited to new activities by impregnation and gestation, and each and every organ is invaded by the stimulus of increased assimilation or elimination. The work of organization and construction is carried on, completed, and equipped. The organism charged with such momentous formative energy also provides consentaneously for the consumption and disposal of the débris and of the waste and effete products. All this is accomplished in a limited time, and then the whole abruptly terminates in suffering, attended with more or less violence, and followed immediately by retrogressive and developmental changes. These complex and important processes cannot be defined by any sharp and uniform line of limitation at which the physiological ceases and the pathological begins. The closure of the torn vessels, the involution of the uterus and pelvic tissues, the exfoliation of the decidua, the re-formation of the mucosa, the evolution of the mammary glands, and the secretion of milk present an ensemble of physiological conditions susceptible of easy, and sometimes rapid and insidious, transformation into morbid processes.

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[1] For an elaborate analysis of the methods for reviving asphyxiated children proposed at different times by Hall, Howard, Sylvester, Pacini, Bain, Schücking, Schüller, Schroeder, and Schultze, see *Experimental Researches in Artificial Respiration in Stillborn Children, and Allied Subjects*, Champneys, London, 1887.

The anatomical changes in the blood-vascular and lymphatic systems of the pelvic organs and tissues and the unavoidable traumata of parturition afford easy access for deleterious material. The clinical picture of the puerperal state has no analogue, and in no other condition of human life are the recuperative power and resources so wonderfully and intricately exhibited. But the border-line of normal and healthy conditions is so illy defined, irregular, and easily passed, the onset of disease is often so insidious, and the consequences of delay are so disastrous, that the accoucheur cannot afford to abide the issue of complete development when the diagnosis is plainly exhibited in the picture of a grave disorder threatening immediate danger. He must be on the alert, ready, accurate, and self-reliant.

Labor involves effort, consumption of strength, loss of weight and fluid, and is followed by more or less exhaustion, thirst, and desire for rest and sleep. Usually, after the patient has been comfortably arranged in bed and the chamber is darkened and quiet, she will sleep. If disturbed by any nervous excitement or anxiety concerning the condition of the child, she should be admonished that repose and sleep are necessary, and every cause of apprehension should be removed by such assurances of safety to herself and infant as can be conscientiously given. In many cases she will complain of chilliness, sometimes associated with marked shivering, without any elevation of temperature or disturbance of the pulse. The chills are attributable to exhaustion, cooling of the surface, depletion from loss of fluids by sweating, and diminution of intra-abdominal pressure in consequence of the removal of the pressure of the pregnant womb. They demand no special treatment, and soon subside.

During labor the pulse rises, being more frequent during the pains than during the intermissions. After delivery it rapidly subsides, falling during the succeeding twelve hours below the normal, and sometimes continuing so for some days, in rare instances oscillating between forty and fifty. No satisfactory explanation for this post-partum slowing of the pulse-rate has been offered, but it is generally regarded as a favorable symptom. On the contrary, when the pulse rises after delivery and reaches 120 during the first or second succeeding hour, it is ominous of hemorrhage. In such cases every precaution should be taken to avoid the impending danger. The accoucheur should not absent himself until assured that the crisis is past.

The temperature of a woman in labor always rises above normal. In ordinary natural labors the elevation is insignificant, but it may continue above the normal for some hours after delivery. In most cases the temperature falls to normal, and in rare cases slightly below, during the first twenty-four hours. Before the introduction of antisepsis in midwifery another and more marked elevation was always expected toward the close of the third or beginning of the fourth day, usually denominated the "milk fever." Those who diligently and intelligently practise antisepsis during the puerperal state do not expect any febrile movement, and are surprised at an elevation above the so-called physiological limit of 100.5°.

In rare cases, more especially in multiparæ, after-pains are very troublesome, but if care has been taken to secure firm contraction of the uterus and to expel any clots forming during the hour succeeding labor by firmly compressing the organ after the method of Credé, such pains will not often harass the patient. It is held by some that such post-partum contractions are salutary, conducive to the condensation and involution of the uterus and expulsion of the clots. It is not improbable, however, that the contractions are excited by the presence of the clots. The reflex contractions occurring during the suckling of the infant are certainly physiological, but the ordinary clinician will probably continue to class the "after-pains," as usually seen, as pathological phenomena amenable to medication. If such pains recur at short intervals and are associated with a rise of the temperature, some inflammatory complications may be anticipated. As a rule, the "after-pains" will be relieved with a moderate dose of the sulphate of morphia dissolved in half an ounce of camphor-water, with ten or twenty grains of the bromide of potassium.

Retention of urine during the first and second days is a very common and troublesome complication, especially among the primiparæ in the higher walks of society. It seems to have become a fashion among this class of females to refuse to make any attempt and to resist any inclination to evacuate the bladder for several days after confinement. It is a nervous condition, induced by the sensation of localized soreness and fear of being hurt. In such cases micturition may be effected by bathing the external genitalia with warm water or by administering a hot-water vaginal douche, or by the more æsthetic expedient of pouring water in an attenuated stream from one vessel to another, so as to be heard and seen by the patient. If these efforts fail, the catheter must be employed. In some cases retention of urine is something more than a nervous phenomenon. The bladder may have been paralyzed by distension, the urethra may have been contused during the labor, or the meatus may be occluded. The structure of the urethra may be swelled and infiltrated and the channel obliterated by congestion and swelling of its mucous lining. Such cases can only be relieved by the employment of the catheter, a soft and flexible one being preferable. Great care should be taken to make the instrument aseptic, and its introduction should be executed with gentleness, or unnecessary pain may be produced. The bladder should be evacuated every eight hours, and oftener if necessary.

The loss of weight during labor is estimated at one-ninth, due to evacuation of the womb, loss of blood, and to increased exhalations from the lungs and skin. This loss continues during the first week of the puerperium, and is attributed to the lessened amount of food taken, lochial discharge, increased secretion of urine, continual increased pulmonary and cutaneous exhalations, and to the secretion of milk. The total estimated loss during labor and the puerperium amounts to *one-fifth*[1] of the whole weight of the body at the advent of labor. During the later weeks of the woman's convalescence she begins to regain weight, but in a large proportion of cases the entire loss is not restored until the period of lactation has terminated. This is more often the case with primiparæ than multiparæ.

INVOLUTION OF THE UTERUS.—The retrogressive changes by which the uterus is restored to its condition previous to pregnancy begin with the advent of labor. The processes of involution involve destruction and reparation. While the muscular fibres and cells which have completed the purposes of growth and development are undergoing fatty degeneration and absorption, new cells and new formations make their appearance. By these changes the organ continuously loses in size and weight; the walls diminish in thickness, but increase in density. A womb which weighed more than two pounds immediately after labor will not weigh more than three-fourths of a pound at the beginning of the third week, and usually at the close of the sixth week the process is completed; but the uterus never resumes the size and shape of a nulliparous organ.

THE CERVIX.—After delivery the cervix is elongated, soft, pulpy, and gaping, but the process of involution proceeds rapidly. At the end of twelve hours the cervix is well defined and the internal os is contracted to about two fingers' breadth. In ten or twelve days the cervix is reduced to about one inch in length; the internal os will not admit a finger, but the external os remains patulous. The os tincæ never resumes its virgin shape and size, but remains enlarged transversely, marked by a lateral depression, with thickened anterior lip. If laceration has occurred it may gape, with rolling out of the labia.

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[1] Gassner and Hecker found a diminution of one-twelfth.

CLOSURE OF THE SINUSES.—It is generally taught that during the eighth month of pregnancy some of the uterine sinuses are obliterated by the coagulation of blood. After delivery thrombi are formed in the open sinuses. These thrombi undergo organization, and by gradual shrinkage the sinuses are completely obliterated, but the process is not completed until the fifth month after labor.

Some of the arteries are destroyed by compression of the muscular structure, and their walls undergo fatty degeneration and absorption. Others are diminished in calibre by uterine involution, and remain.

THE VAGINA.—The vagina after delivery is very large, with relaxed and soft walls. Involution proceeds gradually during the period of puerperal convalescence, but the vagina never returns to the size and condition of that of a woman who has never given birth to a child.

RE-FORMATION OF THE MUCOUS MEMBRANE.—The re-formation of the mucous membrane proceeds with the progress of involution. The outer or superficial layer of the decidua is mostly detached and expelled with the placenta and secundines, but fragments remain attached to the inner layer, which latter consists mostly of the fundi of the glands. The fundal extremities of the glands are lined with epithelium. As involution proceeds the adherent fragments of the outer layer exfoliate and are discharged with the lochia. With progressive condensation of the uterine tissues the glands are pressed closely together and forced into a perpendicular direction. Proliferation of the epithelial lining of the glands takes place, and extends along the gland-walls to the surface of the uterus. From these numerous gland-foci, by continuous extension and growth, the mucous lining of the organ is completely re-formed. This process is completed at the end of the fifth week, and the inner surface of the uterus is completely reinvested with a new mucous membrane. At the placental site the process of regeneration is slower than at other parts of the uterine surface.

THE LOCHIA.—The lochia is the discharge following delivery. At first it is red and consists of blood, but in the course of a few hours it will usually contain also bits of decidua, and perhaps small fragments of the placenta and membranes, together with the secretions from the cervix and vagina. For the first two or three days, whilst red and consisting mostly of blood and the exfoliated débris, it is known as the lochia rubra, but with the diminution of the blood and the increased serous exudation from the inner surface of the uterus, which takes place during the third, fourth, and fifth days, the red color is gradually lessened and the discharge becomes sero-sanguinolent in character, known as the lochia serosa. The quantity of blood-elements continues to decrease, but the pus-cells, fat-granules, free fat, epithelial cells, and crystals of cholesterin increase until it assumes, during the second week, a grayish or yellowish color and creamy consistency, distinguished as the lochia alba. It continues to diminish in quantity, loses opacity and consistency, and ceases between the second and fourth weeks. The discharge is alkaline at first, then neutral or acid. If the patient rises from her bed too soon or makes too much effort, there is apt to be some return of a red show; or if she fail to nurse the infant, the quantity and duration of the discharge may vary from the ordinary course. Primiparæ have less flow than multiparæ. The quantity of lochial discharge during a natural puerperium is estimated at three and a quarter pounds. After the first few days there may be some odor, but if rigid cleanliness is observed and antisepsis diligently practised, there will not be any fetor. In some cases the discharge is diminished during the establishment of the mammary secretion.[1]

Position and Size of the Uterus.—After the delivery of the placenta and secundines, and after firm contraction has been secured, the uterus can be felt as a firm hard mass, pyriform in shape, above the symphysis pubis. It is somewhat anteflexed, with the fundus directed toward the abdominal walls; measures in width about four and a half inches, and in length, by the sound, about six inches. If the patient is in the recumbent posture, with each hip on the same level, it will rest in the median line, but if the rectum is distended with feces or the bladder full of urine, it may be pushed to the right side. The womb is not so large after first as after subsequent labors. During the first twenty-four hours the fundus will reach the navel. As involution proceeds it descends, and about the tenth day it will be slightly above or on a level with the symphysis. If any enlargement takes place, it is due to some morbid condition, but care must be taken to exclude displacement caused by a distended rectum or bladder.

The Changes in the Mammary Glands.—The changes which take place in the mammary glands are developmental. Milk is the natural aliment of young animals. Maternal lactation is the natural method of supplying it to the infant. The secretion of milk is the ultimate product of those changes in the glands which begin with pregnancy and are completed during the earlier days of the puerperium. Lactation begins with the birth of the offspring and continues for an indefinite period. The function is not suddenly established. The periodical evolution of the breasts corresponds with the progress of pregnancy. Both processes are gradual. No other organs in the body, except the uterus and ovaries, are subjected to similar periodical changes. The processes of periodical evolution and involution are in inverted parallelism. The former is as necessary to promote the secretion of milk as the latter is to restore the gland to a normal quiescent condition—to await rehabilitation and renewed functional activity with a succeeding pregnancy.

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[1] Micro-organisms are constantly found in the lochial discharge, but in a strictly normal case they should not be pathogenic. In the vaginal secretion is found the infusorium Trichomonas vaginalis.

The gland structure is composed of lobes, lobules, and acini. These, with the lymphatic structures, constitute the secretory apparatus of the mammary glands. The canaliculi of the acini unite and form the canals of the lobules, and by anastomoses of these canals the lactiferous ducts are formed. The ducts terminate in the nipple by openings varying in size from one-sixteenth to one-fortieth of an inch. As the ducts approach the nipple their calibre is very much enlarged, so that they resemble an elongated sinus, but is again diminished to about one-twenty-fifth of an inch in that part which penetrates the nipple. The interlobar spaces are filled with fatty tissue, and the whole mass of the gland is held together by connective tissue and covered by smooth soft skin with an underlying layer of adipose tissue.

The secretion of the glands prior to labor and during the first three or four days of the puerperium is known as colostrum.[1] It is a yellowish fluid composed of fat, sugar, albumen, water, and salts, and is supposed by some to possess laxative properties. In this viscid fluid is suspended free oil-globules and masses filled with oil-globules known as colostrum-corpuscles. Colostrum possesses an alkaline reaction and contains about 17 per cent. of solid matter.

Colostrum is replaced by milk, usually in three or four days, though occasionally the change is delayed for several days. Milk is a liquid composed of a fluid transudation from the blood and contains products of gland-secretion. It contains from 2 to 7.6 per cent. of butter, from 3 to 6 per cent. of milk-sugar, casein, water, and salts. It is a more digestible fluid than colostrum, with a higher percentage of water and less of solid matter.[2]

MILK FEVER.—In times past it was generally believed that the occurrence of fever during the establishment of the secretion of milk was an unavoidable interruption of puerperal convalescence. Only the exceptional few escaped. Now the reverse is known to be true. This marked and salutary change in the ordinary condition of the lying-in is undoubtedly due to the more careful management of puerperal convalescence and the observance of antisepsis. In rare cases toward the close of the second day, but more frequently a day or two later, the breasts become turgid, sensitive, and more or less firm, occasionally associated with some tenderness of the axillary glands. There may be present a sense of general discomfort, some restlessness, more or less impairment of the appetite, a moderate rise of the temperature, and slight increase in the pulse-rate. The ordinary physiological limit of 100.5° of temperature is too high. This has been very clearly shown by the recent observations in maternity hospitals and private practice. In those cases of temperature elevation to or above 100.5° such rise is the result usually of either neglect of antisepsis, indiscretion in diet, loss of sleep and rest, incomplete evacuation of the bowels, or some nervous perturbation. There is another class of patients in which fever occurs, the temperature rising two or more degrees above the so-called limit, preceded by a well-marked chill. In such cases the functional evolution of the glands has been interrupted by retention of the secretions or by improper handling of the breasts, due either to some defect or condition of the nipples which makes nursing painful, or to disinclination or refusal of the mother to submit to the painful annoyance of nursing, or perhaps to some condition of the infant which incapacitates it for nursing. It is not possible by any method of treatment or management to avoid the discomforts which are necessarily associated with the tension, fulness, and tenderness of the mammary glands during the period of complete functional evolution; but a rise of temperature to 100.5° is not a necessary concomitant, and may be avoided in much the larger number of puerperæ. Proper preparatory treatment of the nipple, especially among primiparæ, and the prevention of fissures and cracks during the first two or three days after confinement, are important and essential protectives against temperature elevation.

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[1] The milk-secretion resembles the secretion of sebaceous matter and seminal fluid. It is a process of cell-proliferation and cell-degeneration. The epithelial cells in the glands proliferate, are infiltrated with fat-globules, and ultimately perish. By their disintegration the fat-globules are set free. "A colostrum-corpuscle is the still coherent globule which results from the fatty metamorphosis of an epithelial cell" (Barnes).

[2] The quantity of milk is about 400–500 grammes on the seventh day. After the second week it reaches 1500–2000 grammes.

DIAGNOSIS OF THE PUERPERAL STATE.—The diagnosis of recent puerperality ought to be readily made by the size, position, and condition of the uterus; the color, quantity, and character of the lochial discharge; the enlarged and lax condition of the vagina; the development of the mammary glands and the presence of colostrum; the condition and appearance of the abdominal walls; and by the general loss of weight. The external os is open, and the cavity of the cervix is elongated, with gradual diminution toward the internal os. The os tincæ is usually torn at its lateral margins, and perhaps deeper into the structure. The perineum is relaxed, contused, somewhat swollen by infiltration, and more or less lacerated along the median line. The tissues of the vulva are soft and flabby, with abrasions on the mucous surface and tears at the orifice. The fourchette is most usually torn. Deep and extensive lacerations may be present, either involving all the tissues of the perineum or limited to the mucous membrane. The nipples are erect, tender, and surrounded by well-marked and deeply-colored areolæ. The later stages of convalescence are characterized by the gradual subsidence and disappearance of these conditions. The involution of the uterus is marked by continuous and gradual diminution of the uterine tumor, changes in the color and character of the lochia, healing of the slight tears in the utero-genital tract, contraction of the internal os, continuous lessening of the cervix in length and size, and gradual diminution of the capacity of the vagina. The replacement of the colostrum by the establishment of the milk fixes the period of complete functional evolution of the breasts. All these changes take place with comparative regularity, and are marked by appearances sufficiently defined to indicate the period of convalescence.

The directions in regard to the care of the patient and infant during the earlier hours of the puerperal state having been given in the sections relating to the management of the third stage of labor and the period immediately succeeding (see p. 505), it remains to consider the after-treatment of her convalescence and the proper attentions to the child. This involves such methods, means, and conduct as will protect her from complications and accidents, promote progressive improvement and final recovery from the conditions and injuries of parturition, and secure the healthy growth and development of the child. If such directions have been faithfully and intelligently carried out, the accoucheur at his first visit will usually find the patient refreshed by rest, sleep, and food, with a normal pulse, perhaps slightly subnormal temperature, free from pain, quiet in mind, resigned to the unavoidable discomforts of her condition, and enthusiastic with the awakened pleasures of maternity.

*First Visit.*—The first visit should be made during the succeeding twelve hours, and sooner if the conduct of the labor has excited any suspicion of unsatisfactory progress; and it will usually prove wise to make a second visit during the twenty-four hours succeeding delivery. At the first visit the accoucheur should, by careful inquiries, ascertain the exact condition of the patient—the duration and character of sleep, and, if interrupted, the cause; the presence or absence of pain; the amount of lochial discharge; the state of the bladder, the pulse, and the temperature; the amount and character of the food and drink taken; the condition of the breasts and nipples; and the extent and degree of abdominal tenderness. He should take nothing for granted, but verify every statement of the nurse by personal inspection and examination. Such minute and careful investigation will often save trouble and avoid disagreeable interruptions of convalescence. If the patient's condition is satisfactory, the visit should terminate with such explicit and positive directions as his judgment may approve. Subsequent visits should be made daily for a week, or longer if necessary, and after the first week a visit once a week during the puerperal month will be judicious.

*Evacuation of the Bladder.*—The bladder should be evacuated at least once every eight hours. If the nurse is competent and the simple expedients before referred to fail, the employment of the catheter may be entrusted to her; but no loose and indefinite statements in regard to the quantity of urine voluntarily passed or drawn off should be accepted to avoid the disagreeable duty of its introduction. It is never wise to permit the patient during the first three or four days of the puerperium to sit upright on a commode to empty the bladder. If her prejudice against the use of the bedpan or inability to pass water in the recumbent posture is insurmountable, the employment of the catheter is preferable to the effort necessary to assume the sitting posture on the commode. The instrument should be employed without exposing the person of the patient, which can be easily accomplished by ascertaining the location of the meatus with the index finger of the left hand and gently inserting the beak of the instrument, and slowly pushing it along the urethra until the urine is discharging at the other end into the vessel in readiness. When the evacuation has been completed the end of the instrument should be closed with the finger to prevent dripping, and it should be slowly withdrawn. Before its introduction the parts should be gently bathed with tepid water to avoid the possibility of causing cystitis by the introduction of foreign matter, and special care should be taken to make the instrument aseptic. Catheters in common use by the most intelligent nurses need special care in this regard.

*Food.*—Previous to the evacuation of the bowels—that is, during the first three or four days, the patient should be confined to a liquid diet of such easily digestible and nutritious aliments as may best suit her taste and caprices, such as milk, animal broths, chicken broth, and gruel. In some cases bread thinly sliced and dried in an oven, milk toast, or corn-meal mush and milk may be allowed. Tea and coffee are not inadmissible. Some food should be taken at intervals of three or four hours during the waking hours. Lying-in women need food to replenish waste, to restore strength, and to meet the demands of milk-production. Whilst care should be taken to avoid starvation, equal care is demanded to escape overfeeding and consequent digestive disturbances. After the bowels have been thoroughly evacuated a more generous diet may be allowed — at first, lamb chops, soft-boiled eggs, birds, tender beefsteak, with bread, properly cooked potatoes, or hominy. Fresh vegetables, acescent fruits, desserts, rich condiments, and the entire list of candies, sweetmeats, and bonbons, should be interdicted during the time the patient is confined to the bed. As the convalescence progresses and the patient has acquired strength sufficient to sit up and to concern herself in the ordinary duties incident to recovery from labor, she may gradually resume her accustomed diet, avoiding excesses and indulgences which disturb digestion and unfit her for the proper discharge of the duties of maternity.

*Attention to the Bowels.*—The routine practice of moving the bowels on the third day is a good one, but it is not an inflexible law. In this as in other details pertaining to the management of the puerperium intelligent discretion will often prove wiser than blind adherence to fixed rules. A foul tongue, headache, and alimentary disturbance will sometimes make an earlier evacuation of the bowels necessary. The writer has recently witnessed a very severe cholera morbus occurring twelve hours after labor at the eighth month in a patient who had dined the previous day on canned corn and sweet potatoes, without detriment or other interruption of her convalescence. The laxative should be selected with reference to the habits and peculiarities of the patient. That which she may have habitually used is usually preferable. The compound licorice powder, made after the German formula; the compound rhubarb pill, a combination of calcined magnesia and blue mass; the Friederichshall and Hathorn waters or some saline aperient,—will fulfil the indications. A half-ounce dose of castor oil is not without merit. A better plan is to administer the night of the second or third day a small clyster composed of equal parts of tepid water and olive oil, or four or five ounces of tepid water and one or two ounces of castor oil with the yelk of an egg, or the same quantity of tepid water and an ounce of glycerin. Such enemas will be retained for considerable time, and usually produce a free evacuation early during the succeeding day. If the bowels are not sufficiently evacuated during the succeeding day, give the next night some laxative by the mouth. A proper dietary will often secure movement of the bowels, and if any necessity for immediate evacuation should occur an active enema will best meet the indication. Daily evacuation of the bowels is very desirable, but circumstances must be considered. The continuous use of purgatives without allowing opportunity for spontaneous movements to occur is not prudent.

*Sleep.*—The importance of sufficient sleep should be impressed upon the patient. Her anxieties concerning the infant should be quieted. The child should be taught to respect the necessities of the mother, and as soon as practicable it should be nursed at a fixed hour at night and put to sleep, so that the mother can rest undisturbed for six consecutive hours. This can be easily accomplished by systematic training of the infant, and no palaver of the nurse, protestation of the mother, or interference of idle and intermeddling friends and over-zealous and anxious grandmothers should be permitted to interrupt this simple but important rule of practice.

*Posture in Bed.*—Continuous dorsal decubitus is tiresome and unnecessary. If permitted, the patient will usually seek the posture most comfortable to her. Change of posture is restful. If the binder is properly adjusted and kept in place, the uterus will not roll from side to side as the patient changes position. When not contraindicated, after the first four or five days a semi-recumbent posture may be allowed at pleasure.

*Attention to the Lochia and Cleanliness.*—Antiseptic midwifery demands the utmost cleanliness. The poison of puerperal septicæmia either originates from the decomposition of coagula, lochial discharge, or the presence of other organic matter resulting from the labor, or is conveyed to the patient by the accoucheur or nurse or by the atmosphere of the room. There may not be as much renown in preventing as in curing septicæmia, but there is infinitely more satisfaction to the conscientious obstetrician. Cleanliness is the first law of prevention—cleanliness of the person and clothing of the patient, of the bed and bed-clothing, of the room, and of the appurtenances and utensils of the lying-in chamber. The discharges and the vessels and clothing containing them should be removed; so also wash-water, wash-rags, soiled towels, and all unclean things. Vaginal pipes, enema-tubes, catheters, and all other instruments and appliances must be kept scrupulously clean.

The progressive changes which take place in the color and character of the lochia have been described. It is not equally abundant in all women, but is supposed to vary in quantity according to their menstrual history. If too profuse or too long continued, ergot may be employed either by the mouth or in the form of rectal suppositories made of the aqueous extract, or ergotin may be used hypodermatically.

During the continuance of the lochia napkins or pads made of some soft and cheap material should be kept in position to receive the discharges and protect the clothing of the patient and the bed-linen from soiling. Such napkins or pads should be burned after being used. Garrigues' antiseptic pad or some modification made of equally soft and absorbing material will fulfil the requirements of neatness, softness, cheapness, cleanliness, and convenience. After the removal of each and every pad, and after each evacuation of the bladder and bowels, the parts should be gently washed with tepid water and then bathed with some antiseptic fluid.[1] Every pad or napkin should be sprinkled with the same fluid before its application. A warm vaginal douche should be given twice daily during the first week; in occasional cases one would prove sufficient. The fluid for the douche should be prepared as described in the note, but double the quantity of carbolic acid may be used, or a bichloride solution, varying in strength from 1 to 2000, 3000, or 4000, may be preferable. A Davidson's syringe with a hard-rubber nozzle is better than a fountain syringe. The beak of the nozzle should be smooth, with openings around its circumference and none at the centre of the end. The nozzle should be introduced so that the end is well up in front or behind the cervix. It is barely possible to avoid the entrance of some fluid into the cavity of the womb previous to the contraction of the internal os, but such care should at least be taken as to avoid thrusting the nozzle into the cervix. The writer has witnessed two cases of very severe uterine colic, followed by a terrific febrile explosion, resulting from improper and careless employment of the syringe. In one case the lady, in a fit of passion, seized the instrument and thrust the nozzle into the cavity of the womb; in the other case the nurse introduced the end of the nozzle just within the introitus vaginæ. It is possible—in fact, very probable—that during the earlier days of the puerperium, when the cervix is expanded and the internal os widely open, that a portion of the fluid injected may enter the cavity of the uterus; but if the instrument is properly used the fluid can only enter by its own pressure, and will flow out with the escape of the fluid from the vagina. A bedpan should be so placed as to favor free exit of the fluid from the vagina. Such gradual entrance and free escape of a portion of the fluid from the cavity of the uterus is not believed to be detrimental. It is only in those cases where the fluid is forced by a direct stream or its escape is obstructed and accumulation follows that injury is inflicted. In those cases where the writer has felt compelled to use hot water intra-uterine injections immediately after delivery the "getting up" of the patient has been undisturbed.

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[1] Such a fluid may be prepared by mixing one ounce of liquid carbolic acid with seven ounces of glycerin. Mix one half ounce of this preparation with one quart of warm water when needed for use.

*Sanitation and Police of the Chamber.*—Sanitation of the chamber during the puerperium is equally if not more important than during labor, and the rules for and methods of ventilation and protection from contaminating effluvia before referred to are equally applicable and should be observed with even greater care. The shutting up of a parturient woman in a dark room, with the blinds, doors, and transoms closed, and the windows and doorways hidden by curtains and portières, may be æsthetic, but certainly is not conducive to convalescence. During the sleeping hours or when quiet and rest are needed a darkened room may not be inappropriate, but fresh and pure air, of suitable temperature, and plenty of sunlight, have not often retarded recovery from parturition.

The room should be kept quiet. The intrusion of gabbling visitors, whose chief avocation in life is to picture the precise resemblance of the patient's ailments or discomforts to those of some dead or dying friend, should be prohibited; in fact, during the first week it will prove wisest to exclude all persons except the necessary attendants and the husband. Nor should those whose presence may be necessary engage the patient in loud and noisy conversation or weary her with unnecessary and idle details of current events. Nor should her quiet, rest, and sleep be disturbed by noise in the dwelling. If the mother is disturbed by the cries of the infant, it should be removed to an adjoining room.

*Nursing and Care of the Breasts.*—The nursing of one's offspring is the highest privilege and duty of maternity. No woman who refuses to discharge, or deliberately incapacitates herself for, this duty can fulfil the obligations of a mother. Only those who may be unfitted by physical disability can be excused. It will, however, occasionally become the duty of the obstetrician to deprive an affectionate and dutiful mother of the coveted privilege because of bodily affliction which unfits her for lactation or makes it detrimental to the infant. Mothers suffering from phthisis, epilepsy, or syphilis should not nurse their babies. Social and society demands should not excuse a mother. A woman who cannot or will not forego the ephemeral pleasures and pastimes of society should eke out her life as a barren spinster.

The child should be nursed not later than three hours after the completion of labor, unless the mother should be asleep, and then upon awakening. It is sometimes judicious to put the infant to the breast before leaving the house. Nursing excites contraction of the womb, and the earlier the attempt is made the more certain the effect. This circumstance may prove an important therapeutic agent in promoting and securing firm and persistent uterine contraction. During the puerperal month the infant should be nursed every two hours during the day, but not oftener than once in three hours during the night. As soon as practicable—and that will usually be during the second week—the intervals at night should be lengthened, so that the mother may secure six hours of undisturbed sleep. But rarely will there be difficulty in getting the baby to seize the nipple; usually it will do so with great eagerness, and, though the supply of nutriment is very small until the milk-secretion is established, it is usually sufficient and all that need be supplied until Nature has begun to produce the child's natural aliment in ample quantity and its organs are prepared for the higher functions of digestion. Attempts at artificial feeding before the establishment of the milk-supply usually resolve themselves into attacks of colic and screaming spells, which expose the wilful interference of the nurse and clandestine feeding.

The nipples should be carefully bathed with tepid water before and after nursing, and dried with a soft cloth. If tender, cracked, or fissured, they should be pencilled after each nursing with the compound tincture of benzoin, which should be thoroughly removed before the child is again nursed. Careful attention to these details will frequently obviate more serious complications, for puerperal mastitis most often finds its cause and beginning in neglected cracks or fissures. Sometimes, especially in primiparæ, lactation is impossible because of the pain produced by suction, and it becomes necessary to protect the nipples with a shield. The best is that known as the Phœnix nipple protector, which is supplied with or without a tube.

The breasts should be nursed alternately, and during the intervals should be protected from exposure and the irritation of the clothing by some soft material smoothly laid over them. If heavy, tender, and pendulous, they may be supported by a bandage smoothly adjusted and fastened over the opposite shoulder. Soreness of the breasts with threatening mastitis may be allayed by the application of a saturnine lotion. Such a lotion may be prepared by dissolving one drachm of the acetate of lead in one pint of water, to which may be added one or two drachms of laudanum or the deodorized tincture of opium. The breast must be completely enveloped with a piece of soft linen or cotton cloth, with a hole in the centre through which the nipple can protrude, and saturated with the lotion. It can be kept moist by sprinkling it with the lotion while in position. Before nursing the cloth must be removed and the breast carefully washed to avoid the danger of poisoning the infant with lead or opium.

If, as is always proper with primiparæ, the nipples have been subjected to preparatory treatment, trouble does not often occur. The local treatment involves the management of the gland and nipples before and after labor. Any disease of the gland or irregularity in shape or position of the nipple should receive the necessary attention before or during pregnancy. Sore nipples and sore breasts are quite common, and sometimes unavoidable, occurrences after confinement; but with proper care and timely treatment they are usually manageable affections, and do not necessarily permanently disturb the function of the gland. The preparatory treatment of the nipple consists mainly in promoting its projection, size, and form by drawing it out daily with the thumb and fore finger, and hardening the epidermis with daily applications of an astringent alcoholic solution. The treatment of inflammatory complications and malformations of the gland belongs more properly to the article on the Pathology of the Puerperal State, to which the reader is referred.

DURATION OF PUERPERAL CONVALESCENCE.—By common consent the period of puerperal convalescence is limited to thirty days. The custom of remaining in the house and refraining from household duties is so generally and voluntarily observed by women that it may be considered a law. There are many good reasons for this practice. During this period involution of the uterus takes place, and in a majority of cases is completed before its expiration. The patient regains strength and vigor and becomes accustomed to the routine duties of nursing and care of the infant. It is not, however, necessary for her to remain in bed. There is a common belief among women that they must remain in bed during the first nine days. This is the one of the superstitions which is of practical value, because it secures physical rest and mental quietude during the most important period of convalescence, and restrains importunities for permission to do things which are considered wrong or of doubtful propriety. The duration of confinement to the bed varies. Some practitioners hasten the getting up, and others delay it. Neither extreme is wise. As a rule, those who remain in bed during the first ten or fourteen days are in a better condition at the expiration of the puerperal month than those who abandon it at an earlier period. In his early professional life the writer followed the teachings of Hodge and Warrington, but later, when the journals were teeming with the salutary effects of a radical departure from these old-fashioned ideas, and enforced sitting up during the later days of, or at most at the expiration of, the first week was insisted upon, he accepted and practised the procedure. For a time the results seemed to demonstrate its wisdom and utility, but a few sad experiences called a halt, and he resumed the earlier method, the wisdom of which has been confirmed by more careful observation and later and more extensive experience.

ATTENTION TO THE CHILD.—During the first visit after the delivery the obstetrician should inquire into the condition of the infant. As a rule, he will learn that the bladder has been evacuated and that one or more discharges of meconium have taken place. Sometimes the passing of water and movement of the bowels will be delayed; but if the child is quiet, sleeps and breathes without disturbance, such delay for a few hours need occasion no alarm nor will it be necessary to administer drugs or potions. The food obtained by nursing will prove sufficient.

The caput succedaneum will subside and disappear in twenty-four hours. The head will slowly resume its normal shape. Exfoliation of the epidermis usually begins about the third day, and is completed at the expiration of a week. The deep red color of the integument fades, passing into a yellowish hue. The stools change from black to yellowish, and become feculent. During the first three or four days the child loses in weight, but as soon as the evolution of the mammary secretion is completed and sufficient nutriment is supplied it begins to regain weight, and usually at the expiration of the first week it has regained the lost weight.

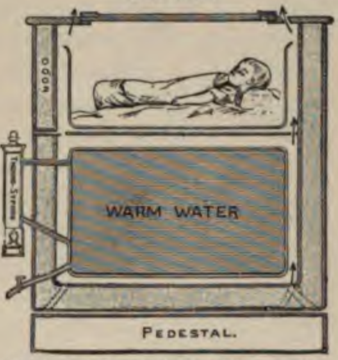
The cord falls off in four or five days, leaving a raw surface, which should be washed and dusted with the subnitrate of bismuth or dressed with carbolized ointment. It should be carefully watched until entirely healed.

Icterus neonatorum is a rare affection in private practice among the infants of well-to-do people in this country. It usually attacks the child during the first day or two, and disappears spontaneously in a week. It most frequently occurs in premature and feeble infants and in those subjected to bad hygienic surroundings. Medication is unnecessary and often detrimental.

Nurslings should not be allowed to continue at the breast when asleep, but should be removed as soon as they have finished, nor should they be permitted to remain in the same bed with the mother. A properly prepared and conveniently arranged crib is the proper resting- and sleeping-place for the newborn. It is equally improper to permit the nurse to hold the baby on her lap except when performing some necessary duty. All unnecessary handling and coddling of babies brings trouble. A properly fed and sleeping baby is a well baby; a crying and colicky baby is one that is poorly nourished, badly or improperly fed, or dosed with teas or medicines.

Feeble and premature infants need special care. Tarnier's success with the "hatching-cradle" has demonstrated the importance of proper management of weak and immature infants. The incubator consists of a wooden box with walls 0.10 to 0.12 centimeter thick, filled in with sawdust to prevent loss of heat. A central partition divides the box into two compartments, the one for hot water, the other for the infant's cradle. A metal case, of a capacity of about 71 liters, fits into the lower compartment, leaving a space of 2 to 3 centimeters between its walls and those of the box for the free circulation of air from below upward. The capacity of the upper compartment is about 86 cubic centimeters; there is free circulation of air between it and the lower compartment, and it is in communication with the outer air by means of two openings—the one on its upper surface shut in by a double plate of glass, the other, laterally, opening like a door and allowing exit to the cradle. In each corner of this upper compartment is a hole for the escape of the heated air from below. To the lower compartment, containing the hot water, is attached a thermosyphon by an upper and a lower tube. When the lamp under this siphon is lighted, the heated water flows through the upper tube into

Fig. 221.



Section of Tarnier's Hatching-cradle.

the chamber, displacing an equal amount of water, which flows back to the siphon. Thus a current is established the temperature of which can be raised to the desired point. In cold weather it has been found necessary to light the lamp three times daily, allowing it to burn each time about two hours. The lamp should be extinguished when the temperature in the upper compartment is about two degrees above the heat desired. The registering thermometer may be laid alongside the infant.[1]

But every accoucheur cannot be supplied with the apparatus. Artificial heat and well-regulated alimentation are the resources of successful management. In all such cases the mother's milk is the best food. If the infant cannot grasp the nipple or is too feeble to suck, the milk must be drawn from the breast and fed to it. If the supply is insufficient or entirely absent, the milk of some animal, preferably that of the cow, properly diluted and prepared, must be substituted. The ordinary management of such cases may be illustrated by the following reports of two cases:

A lady having been greatly frightened by a thunderstorm during a heated term in July was prematurely confined at the sixth and a half month. The infant, without being washed or dressed, was immediately and securely wrapped in cotton wool, so arranged about the face as to prevent any obstacle to respiration and to afford easy access to the mouth. The father took charge of, and devoted himself assiduously to, its care. The secretion was drawn from the mother's breast by suction with a pump and gentle pressure, and fed regularly, at brief intervals, to the infant by means of a dropper. This is a glass tube slightly curved at the beak, with a small elastic bulb attached to the other end. The whole apparatus when full holds about twenty minims of fluid. The infant is fed by gently introducing the beak of the instrument into the mouth with the end well down toward the base of the tongue, and then by gentle pressure of the bulb between the thumb and index finger, intermitting or not as may seem best, the fluid is slowly forced out and swallowed by the infant. The quantity of food supplied in the case cited was increased from day to day as the gland secretion became more abundant. At the expiration of three weeks the child was washed and dressed. She is now a healthy and vigorous girl twelve years of age.

The second case was a feeble infant weighing one and three-fourths pounds, born at term. It could not be made to grasp the nipple, nor could anything be obtained from the breast. The baby was washed and dressed as best could be done with such a flaccid, relaxed, and emaciated body. During the first twenty-four hours two minims of brandy in a dropperful of warm water was administered regularly every two hours. Afterward, for several succeeding days, in addition to the brandy it was fed by the dropper with a warm solution of condensed milk, made in the proportion of one part of milk to sixteen of warm water, beginning with a dropperful every hour, and gradually increasing the quantity and prolonging the interval until the child, at the expiration of the first week, had gained sufficient strength to omit the stimulant and could take from one to two ounces of the milk solution every two hours. As soon as the infant could suck, an ordinary nursing-bottle was employed. The result was entirely satisfactory.

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[1] Auvard: "De la couveuse pour enfants," *Arch. de Tocologie*, Oct., 1883, p. 577. The account given above is copied from abstract furnished to the *Am. Journ. of Obstet.*, April, 1884, by Robert H. Grandin.—(*Taken from Lusk.*)

These cases have been introduced to show how easily, with ordinary care and proper alimentation, premature and feeble infants may be saved, but the method is not comparable to Tarnier's "hatching-cradle." Since the introduction of this machine in the Maternité at Paris the mortality of premature infants has been reduced from 66 per cent. to 36.6 per cent.

The general management of cases of scanty and defective lactation consists in local and mechanical, hygienic, dietetic, and medicinal treatment. A discussion of the details of these several methods would involve an elaborate and unprofitable review of the subject, concerning which a vast amount of nonsense has been written, and for the treatment of which many remedies have been recommended, both by physicians and laymen, with which the writer has had no experience, and of the value of which there is no confirmatory evidence. Nevertheless, the subject is too important to be passed without comment.

Various local and mechanical means have been employed to provoke and increase the flow of milk. Suction, titillation of the nipple in imitation of the process of milking animals, pressure, kneading, gentle friction, electricity, fomentations, and the application of various stimulating substances have been employed with more or less success. Of these, suction and electricity have yielded the most satisfactory results. Suction is the most certain and powerful means of promoting, increasing, and preserving the lacteal function. This is illustrated by the numerous instances of maidens and barren women, and of the few cases of males, who have established a copious secretion of milk, and by the cases reported by Livingstone, Dunglison, Thorwarth, Waddy, and others of old women who had long before ceased to menstruate and bear children, who reproduced the secretion and nursed their grandchildren. The preferable mode of suction is by the child. Regular and methodical nursing of the baby will often, especially in the cases of natural scantiness of flow and torpor of the function, promote the secretion, and in those cases of defective lactation due to insufficient, irregular, or over-nursing it may completely restore the gland to its normal condition.

Electricity has not been so extensively employed, but in the hands of those who have given it a fair trial the results have been encouraging. It is a valuable adjuvant to suction. It stimulates the nerve-supply and circulation and promotes the nutrition of the gland.

The local treatment of the gland by the application of plasters, ointments, oils, embrocations, and poultices for the cure of any form of defective lactation is useless.

The hygienic treatment refers to personal and domiciliary cleanliness, healthy exercise in the open air, proper sleeping apartments, sufficient and refreshing sleep, fresh and pure air, protection from the debilitating influence of continuous high temperature and from the equally injurious effects of severe cold, and sufficient and proper clothing. The change of residence from town to the country or to the seashore sometimes promotes an abundant flow of good milk. In short, the hygienic rules and regulations which are so conducive to the health of nurslings are equally important for the mothers.

The dietetic is the most important of the several methods of treatment, and yields the most satisfactory results. This is so generally recognized that it is almost exclusively employed. There is, however, no universal diet suitable for every mother, no continuous regimen of specified foods which can be relied upon in every case with uniformity and constancy of results. The general law governing the dietetic management is to supply such foods as are simple, nutritious, easily digested and easily assimilable, and to avoid such as may prove injurious to the nursling. It is worse than useless to attempt to sustain life, and at the same time nurse a baby, upon crude articles, knick-knacks, candies, preserves, pickles, bonbons, together with teas, ptisans, and potations. The watery constituents may be increased, but the nutritive quality of the milk will be deteriorated. A judicious combination of animal and vegetable foods is always desirable. Strong salt foods and indigestible and acescent fruits and vegetables should be avoided. The starchy, saccharine, gummy, and ligneous vegetables should be used in moderation. Neither should the diet be exclusively albuminous. Fats in moderation are beneficial. Oatmeal and barley are generally admissible. Fish, tender birds, crabs, and oysters are considered specially efficacious. Routh recommends whiting soup and conger-eel soup as milk-producing foods.

The proper dietary management of puerperal women, especially during the earlier days of the puerperium, will influence favorably the lacteal secretion. The practice in times past, and one too common now, of limiting the diet of recently-confined women during the first week to tea and toast or some other equally innutritious aliment, has given way to a more generous system of feeding women who have to live themselves and feed another. The process of making milk in the laboratory of one's own person must consume a large amount of force which can only be replenished by food.

There is great diversity of opinion in regard to the value of drinks. Perhaps the rule which governs most women is the special fondness for a particular beverage. Good, pure, wholesome drinking-water, in requisite quantities, is certainly unobjectionable and harmless, and perhaps equally as efficient as the more palatable and valued compounds and mixtures of alcohol. Stimulating and appetizing drinks are sometimes very efficient promoters of digestion, but no healthy nursling needs alcohol, and when sick and needing it, it had better be fed from the spoon than nursed from the intoxicated mother.

To even enumerate the medicines, disgusting compounds, and nauseous mixtures which have been suggested, employed, and extolled as galactopoëtics by their inventors and discoverers would be a waste of time and space. No one but themselves has ever witnessed the benefits which their enthusiasm has so lavishly bestowed. The simple rule of guidance in the medical management of cases of insufficient and defective lactation is to address the remedies to the improvement of the health of the mother. Restore her, if possible, to the condition of a vigorous and healthful woman in the prime of life. So far as this may be accomplished, so far will all be done that can be to restore the sufficiency and richness of the milk.

SUPPLEMENTAL LACTATION.—For the present the primary object is the prevention of the injurious effects of defective lactation upon the young infant. The chief obstacle to the management of such cases is the difficulty of an early recognition of the precise nature of the cause. This difficulty in most instances grows out of the trivial character of the initial symptoms and ignorance on the part of the mother or unwillingness to believe that the cause is attributable to any physical defect of her organism or any impropriety in her conduct or her method or manner of nursing. Generally, the innocent but ill-fed baby is charged with various disabilities and flagrant exhibitions of connate perversities, and dosed with medicines until some serious organic change has taken place. In all cases of defective lactation the baby must be protected, either by removal of the cause of such defect, or by supplementing the natural aliment, or by weaning and artificial lactation. How best to supply the deficiency is an important question. Common sense would reply, With the milk of another woman; but common experience teaches that this method is not only inexpedient and impracticable, but may entail untold evils upon the defenceless nursling. The mercenary wretch who sells her breasts, and thus robs her own offspring of its birthright, leaving it to suffer or perhaps to starve, and often abandoning or destroying it, is not fit, either morally or physically, to properly nourish the child of another.

The model wet-nurse should be a woman of suitable age who has lost her own child at about the same age as the foster-child. She should have a breast of good and abundant milk; be free from actual or hereditary predisposition to disease; possess a kindly disposition and even temperament; have no vicious, gluttonous, lazy, or uncleanly habits; and, finally, be animated by a love of children rather than the money-value of her services. When such an one can be had she will, in some measure, fill the mother's place.

ARTIFICIAL LACTATION.—As milk is the only natural, it should be the exclusive, diet of young nurslings. The milk of an animal is the only suitable substitute for breast-milk, and the only proper supplemental aliment when the mother's supply is defective or scanty. There may occasionally occur an exception to this general law due to some digestive idiosyncrasy of the infant, but most frequently the exception is only apparent and attributable to some impropriety in the management of the baby or some mistake in the preparation or preservation of the milk. Cow's milk is preferable, because it is most abundant, most easily obtained, and is free from any disagreeable odor. To adapt the milk of the cow to the purposes of artificial lactation the proportions of solids and water must be approximated to the percentages found in human milk. This is done by adding sugar and water according to the age of the nursling and corresponding changes which take place in the breast-milk from month to month. This law cannot, however, be followed in every case, for infants differ very much in digestive and assimilating capacities. Most frequently, too much sugar and too little water are added, especially during the earlier weeks of nursing. It often happens that the quantity of water and sugar must be varied from day to day until the proper proportions are ascertained by the evidences of relief and subsidence of digestive disturbances.

Human milk is alkaline, cow's milk is acid, but least so when the animal is pasture-fed. The acidity continuously increases from the time of milking. Consequently, the addition of an antacid is a necessary part of its proper preparation; and this is the more necessary because of the constant tendency of milk-sugar to lactic-acid transformation.

The casein of cow's milk coagulates in firm and dense masses, that of woman in loose and flocculent shreds; hence the latter is more easily digested. The more stale and acid the milk the quicker and firmer the coagulation. Various suggestions have been made to obviate the rapid and firm coagulation of cow's milk, but none have fulfilled the object. Perhaps, says Jacobi, there is no way of making the casein of cow's milk any more digestible than it is as found in the natural condition.

Cow's milk contains more butter than human milk; hence the greater tendency to the formation of fat acids, which are so frequently the cause of disturbances in bottle-fed nurslings. The formation of fat acids in the stomach and their admixture with the pancreatic fluid neutralize its property of emulsifying and preparing the fats for absorption, producing intestinal indigestion. Intestinal digestion, at best, is feeble in very young nurslings. It is always judicious to add to the milk a fluid prepared from barley or oatmeal, the former when diarrhœa is present, the latter when constipation exists; but when either is added the quantity of food given at each feeding should not be increased.

Butter, which is present in so much larger proportion in cow's than in human milk, seems both from experimental investigation and clinical observation to be the constituent most productive of digestive disturbances. Dilution is the most effective method of correcting or obviating this objection.

As a rule, milk is the only fluid a young baby ever gets, and generally, especially in hot weather, this furnishes an insufficient supply of water for the purposes of the animal economy. Water is as necessary as food; in fact, digestion cannot be carried on nor can health be maintained or life sustained without it. But it is not necessary to convert the alimentary tract of a nursling into a common funnel through which all the liquids and slops at a housekeeper's command are to be poured.

The milk from a herd is preferable to that from one cow. As soon as the milk is received—and there should be at least a morning and evening supply of fresh milk—it should be prepared by the addition of hot water or a decoction of barley or oatmeal in quantity sufficient for the proper dilution, to which the alkali should be added. It should then be placed, in a covered vessel, in a refrigerator, and as needed the required quantity should be warmed and sweetened with white sugar. This process of scalding the milk has appeared to secure all the benefits of heat, and, when the other necessary attentions—perfect cleanliness and purification of every utensil employed and of the place of keeping—are carried out, has usually proven satisfactory as a method of preservation.

Artificial lactation may be performed with the spoon, mug, or nursing-bottle; the last is the preferable method. The bottle should be one with a smooth and even internal surface, without shoulders, angles, or corners or inverted bottom, to which should be adjusted, by means of the stopper, a flexible tube with a soft mouthpiece, and attached at the distal end to a glass tube within the bottle. When the child has been fed, any remaining portion of the prepared milk should be thrown away, the different parts of the nursing apparatus separated, thoroughly cleansed, and laid aside in an alkaline solution. When the infant ceases to suck at the mouth-piece the bottle should be removed. The child should not be urged to take food when it has enough, nor should it be allowed to hold the bottle any longer than is necessary, or to dally and play with it, sucking and quitting or sleeping and waking with the mouth-piece held between its lips. The warmth of the body and hands and the lapse of time favor and hasten the deteriorating changes which are so liable to occur in milk.

*Condensed Milk.*—Condensed milk has been very extensively employed as a substitute for breast-milk, and there exists a contrariety of opinion in regard to its value. The writer's experience differs somewhat from either extreme view, and this difference relates to the peculiarities of infants. When prepared with proper proportion of barley-water or oatmeal gruel or largely diluted, it has, in many instances, proven acceptable and sufficient. It is, nevertheless, true that some infants fed exclusively upon it manifest a feeble resistance to morbific agencies, but this is very far from being the general rule.

*Other Substitutes.*—As a matter of fact, there is no such substance or aliment as a substitute for milk. It is true that many children have been reared without ever having tasted breast-milk. It is equally true that the exclusion of breast-milk from birth yields the worst results. It is alleged that there are occasional instances when infants cannot be nourished with milk. Such cases are so rare that the writer cannot recall a single instance occurring in his own practice. The "sugar-teat," corn-starch, and "cracker victuals" ought to be universally condemned. The various manufactured and patented "infant foods" are mere articles of traffic, as unsuitable as they are unreliable. Occasionally an infant in vigorous health is exhibited as an illustration of the remarkable nutritive quality of some one of these compounds, but it is more probably the exhibition of a development attained in spite of them.

The first and most important lesson in the art of feeding the newly born is to teach the parents that they can learn all that is absolutely necessary to know; and the second is to disabuse their minds of the errors which ignorance, superstition, and bad example have inculcated. Every mother knows that milk is the natural aliment of babies, and that hand-feeding is always attended with more or less danger. She knows equally well that the milk of an animal is the only substitute for breast-milk, but she is generally ignorant of the methods of preserving and preparing it.

# ON THE MECHANISM OF LABOR, AND THE TREATMENT OF LABOR BASED ON THE MECHANISM.

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## THE MECHANISM OF LABOR.

By the expression "the Mechanism of Labor" I mean the mode by which the fœtus passes through the cavity of the pelvis and is expelled from the body of the mother.

The fundamental principles of the science of Obstetrics are based on the relationships which are possible between the pelvis and the fœtus passing through it during labor. It is essential, therefore, to take a *preliminary glance* at these relationships before beginning our investigations: for a more thorough discussion of the anatomy of the pelvis and fœtus the reader is referred to the ordinary works on anatomy and obstetrics.

### THE PELVIS.

The pelvis is an irregular bony cavity terminating the trunk inferiorly. It is composed of four bones—two symmetrical bones in the median line behind—viz. the sacrum and coccyx; while its anterior and lateral walls are formed by the ossa innominata.

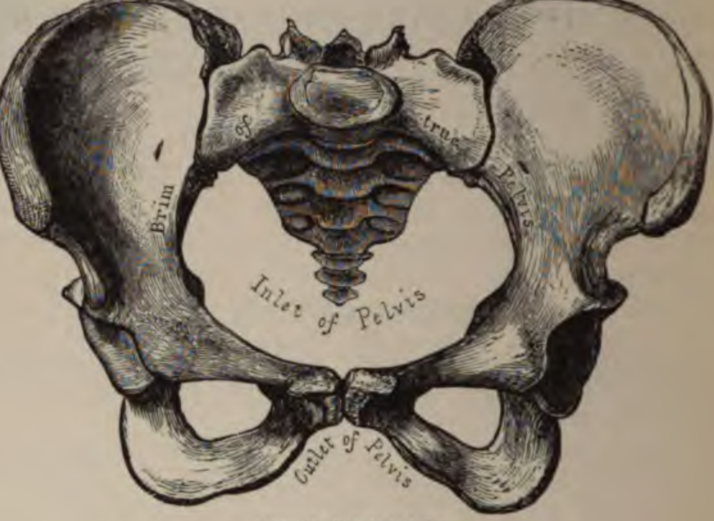
Studied in its general aspect, it may be described as representing a truncated cone slightly flattened in an antero-posterior direction, its base above and inclined slightly forward, the truncated portion below and a little back. We shall pass by the peculiarities of its external surface, and look only at the internal.

### THE INTERNAL SURFACE OF THE PELVIS.

The most superficial inspection of the internal surface of the pelvis shows that Nature has divided it into two distinct portions, the dividing-line being the linea ilio-pectinea. All above this line constitutes the superior or abdominal pelvis; all below, the inferior, the lesser, or the true pelvis.

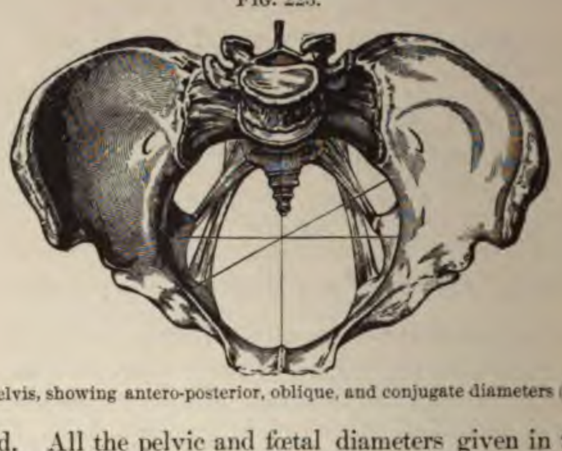
*The Superior Pelvis.*—The superior pelvis is of very irregular figure; it is a species of pavilion or entrance to the true pelvis. It may be described as having a great notch in front, which in the recent subject is filled by the abdominal muscles; a notch behind, filled by the lower lumbar vertebræ; the sides are expanded and elevated by the alæ of ilia. The superior pelvis is of comparatively little importance in an obstetrical point of view, since, unless extremely deformed, it cannot interfere with the passage of the child. Three diameters may be remembered. All the pelvic and fœtal diameters given in this article are those taught by Dr. Hodge, and may be found in his *System of*

FIG. 222.



Female Pelvis (adult).

FIG. 223.



Brim of Pelvis, showing antero-posterior, oblique, and conjugate diameters (Gallabin).

*Obstetrics*, and may be considered as the obstetrical teachings of the University of Pennsylvania from the foundation of the chair of Obstetrics: From the anterior superior spinous process of one side to the same point on the opposite side, *about* nine inches; from the middle of the crest of the ilium of one side to the opposite side, *about* eleven inches. The depth of the superior pelvis from the top of the crest of the ilium to the linea ilia is three and a half inches.

Diameters of the superior pelvis to be recollected: 11 inches, 9 inches, 3½ inches.

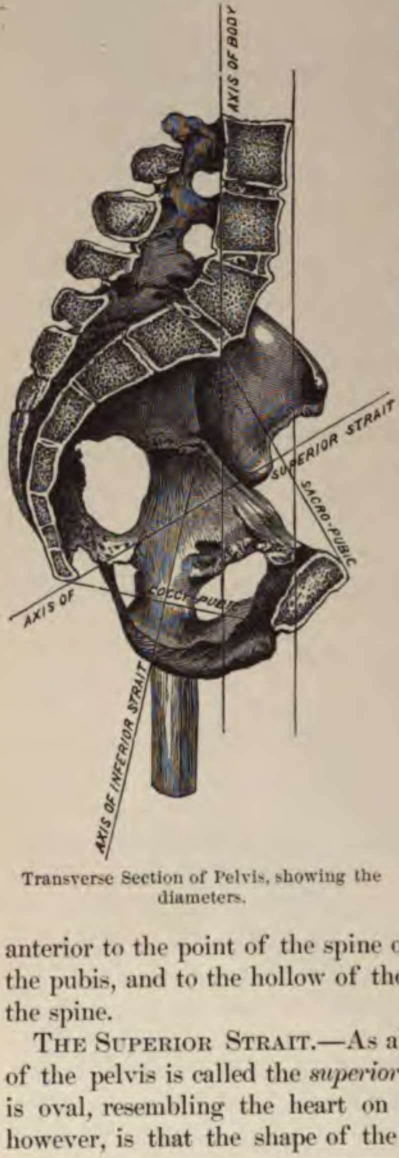
*The Inferior or True Pelvis.*—The inferior or lesser pelvis is the real obstetrical pelvis. If all the parts forming the abdominal pelvis be removed by a saw, a species of bony ring will remain, much narrower in front than behind or at the sides, forming a curved canal larger in the middle than at either extremity, and slightly bent forward. This canal has two openings—the one above, called the *superior strait;* the lower, the *inferior strait.* These are called "straits" because they are more contracted than the space between them, which is called the *concavity* or *basin* of the pelvis. Four regions may be noticed in this cavity.

The *anterior* region is greatly notched by the pubic arch: its bony surface is convex from above downward and concave transversely; the posterior part of the pubic articulation projects vertically in the middle to the extent of two- or three-eighths of an inch; toward the sides we find a smooth surface, and then the internal obturator or subpubic fossa.

The *posterior* region is formed by the faces of the sacrum and coccyx: it is concave from above downward, and exhibits the peculiarities which characterize these bones.

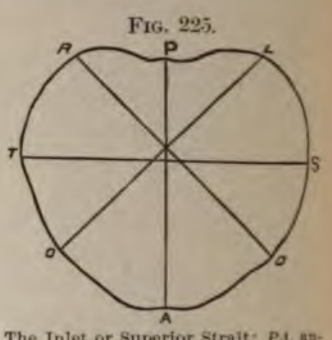
The *lateral* regions present two quite distinct portions. The anterior portion is wholly osseous: it corresponds to the back part of the acetabular cavity and to the body and tuberosity of the ischium; its direction is from above downward, from without inward, from behind forward. The posterior portion is chiefly ligamentous and foraminous, being formed by the internal face of the sacro-sciatic ligaments and foramina. This portion has an opposite direction from the anterior portion, the inclination being from above downward, from without inward, and from *before* backward. If we now make a vertical section, in the median line, through the sacrum and pubis, we divide the pelvis into two lateral halves, and can notice the peculiarities to which we have already referred. A glance will show that the points of the spines of the ischia are the summits of two inclined surfaces on either side—one surface inclining inward, downward, forward; the other surface inclining inward, downward, and backward. We may now make another section of each lateral half by a cut passing from the points of the spines of the ischia vertically to the linea ilia, and we shall then have the pelvis divided into four pieces; and these represent what are commonly called the *inclined planes* of the pelvis. The anterior inclined planes, which are the longer and larger, begin at the points of the spines of the ischia, about one inch in front of the sacro-iliac symphyses, and about the middle of the sacro-sciatic ligament, and, passing obliquely downward and forward, terminate at the anterior edges of the ischio-pubic rami. The posterior inclined planes begin at the points of the spines of the ischia, pass downward and backward, and terminate at the middle of the sacrum and coccyx. The general shape of the pelvic cavity is rather that of a four-sided lozenge than oval, as is commonly supposed. According to many authorities, these inclined planes play an important rôle in the mechanism of labor. They are supposed to influence the movements of the presenting part, causing it, when it strikes anterior to the point of the spine of the ischium, to pass to the arch of the pubis, and to the hollow of the sacrum should it strike posterior to the spine.

FIG. 224.



Transverse Section of Pelvis, showing the diameters.

FIG. 225.



The Inlet or Superior Strait: *PA*, antero-posterior diameter; *TS*, transverse; *RO*, right oblique; *LO*, left oblique.

THE SUPERIOR STRAIT.—As already mentioned, the upper opening of the pelvis is called the *superior strait*. The shape of this opening is oval, resembling the heart on playing-cards; a better description, however, is that the shape of the superior strait in the *bony pelvis* is that of a curvilinear triangle, having its base behind and its apex in front. Constituting as it does the entrance to the true pelvis, and therefore the first part of that narrow canal through which the fœtus has to pass, great pains have been taken to study it.

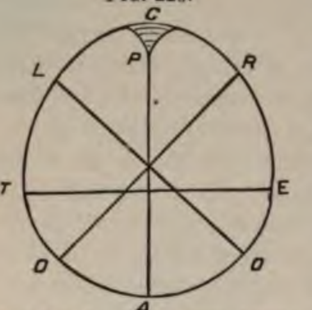
*Plane and Axis of Superior Strait.*—A plane is a surface without thickness. By the plane of the superior strait we mean merely the surface of the upper opening into the pelvic cavity. In a well-formed woman, *when she is erect*, the promontory of the sacrum is three inches and nine or ten lines above the upper margin of the symphysis pubis. It is evident, therefore, that when the female is *erect* the plane of the superior strait is oblique and inclined from above downward and from behind forward. The degree of this inclination is 55° or 60° to the horizon. The degrees of inclination of the plane being fixed, it is easy to determine its axis. The axis of any plane is a line drawn perpendicularly to its centre. The axis of a horizontal plane, therefore, is a vertical line, and the axis of an oblique plane is an oblique line. The plane of the superior strait of the pelvis, *when the individual is erect*, being, as we have just seen, an oblique plane, its axis must necessarily be an oblique line; and we find it to be a line passing from the coccyx through the centre of the plane of the superior strait, and perpendicularly to it, and, if continued, passing out of the body through the linea alba just below the umbilicus. It must be recollected that the obliquity of the plane of the superior strait, and consequently the direction of its axis, depend on the position of the individual. The inclination of this plane is 55° to 60°, as we have just seen, when the woman is *erect:* it is much less oblique when she is sitting, still less when she is bent forward. A knowledge of the axes of the pelvic straits and the pelvic cavity is essential to the intelligent performance of almost all operations during labor.

*Diameters of the Superior Strait.*—As already stated, the measurements given are those recognized as standard in the University of Pennsylvania, and are to be found in Hodge's *System of Obstetrics.*

The circumference of the superior strait measures about thirteen inches and a half. We study three diameters of the superior strait. The *bis-iliac diameter*, commonly called the *transverse*, at the widest transverse distance from one linea ilia to the other, measures, in the bony pelvis, five and a quarter inches. The *oblique diameter*, measured from the acetabulum or the pectineal eminence of one side to the opposite sacro-iliac symphysis, is five inches. The *antero-posterior* or sacro-pubic diameter is measured from the promontory of the sacrum to the upper edge of the symphysis pubis, and is four inches.

THE INFERIOR STRAIT.—The inferior strait of the pelvis is more contracted than the superior, and more irregular in its outline; it possesses three tuberosities or osseous projections, separated by as many deep notches. Its general shape resembles the heart on a playing-card, although the indentation made by the coccyx disappears at the moment of the head's passage in labor, and therefore the shape of the opening may be considered as oval. The tuberosities of the ischia are placed on a plane somewhat lower than the point of the coccyx, and consequently in the sitting posture the weight of the body rests solely on these tuberosities: this circumstance explains why transverse contractions of the pelvis are far more frequent at the inferior strait than the antero-posterior ones. Of the three notches, the two lateral ones, though very deep in the bony pelvis, are made, in the recent subject, very superficial by the sacro-sciatic ligaments.

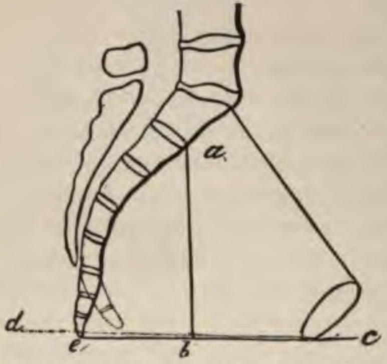
FIG. 226.



The Outlet, as seen from below: *C*, under surface of the coccyx; *PA*, antero-posterior or coccy-pubic diameter; *TE*, transverse; *RO* and *LO*, right and left oblique diameters.

The anterior notch is called the arch of the pubis. The columns of this arch are distorted outward, as if some round and hard body had been forcibly expelled from the pelvis while the bones were soft; and this arrangement, more marked in the female, favors the escape of the head in labor.

FIG. 227.



Sacral Promontory: *cd*, the horizontal line; *ce*, the plane of the inferior strait (during labor); *ab*, the axis of the inferior strait.

*Plane and Axis of the Inferior Strait.*—In consequence of the tuberosities being lower than any other parts of the inferior strait, it is evident that, mathematically, it has no plane; practically, however, we may consider the coccy-pubal line as representing the plane. What is the direction of this line? Undoubtedly, when the female is *erect* and not in labor the point of the coccyx is above the lower edge of the subpubic ligament—about half an inch—and hence under such conditions the direction of the plane is oblique from behind forward and from above downward; but during labor, the only time when the direction of the plane is of any moment, the advancing head pushes the coccyx down and back until its point is on a level with, or even below, the lower edge of the symphysis pubis; hence during labor we may declare that the plane of the inferior strait is slightly oblique from behind forward and from below upward. The axis of this plane, under these circumstances, is a line drawn from the union of the first and second bone of the sacrum through, and perpendicular to, the centre of the plane.

*Diameters of the Inferior Strait.*—The circumference of the inferior strait is about twelve inches. The longest diameter is measured from the subpubic ligament to the point of the coccyx, and is therefore called the coccy-pubal; usually, however, it is called the antero-posterior diameter; it is four inches. The mobility of the coccyx during labor increases this diameter to four and a half inches. The transverse diameter is measured from the inner edge of the tuberosity of one side to that of the opposite, and is hence sometimes called the bis-ischiatic; it is four inches. The oblique diameters are measured from the middle of the ischio-pubal rami to the middle of the opposite sacro-sciatic ligaments, and are four inches. The elasticity of these ligaments increases these diameters a quarter of an inch or more during labor. All the diameters of the inferior strait in the quiet condition of the parts may be considered as four inches, the distensions of labor giving the increase which we have just noticed.

*The Diameters and Axis of the Cavity of the Pelvis.*—The space between the superior and inferior straits is the cavity of the pelvis. It is in this cavity that the presenting part of the fœtus during labor undergoes its characteristic movements and changes, and hence it is important to understand its planes, its axes, its diameters.

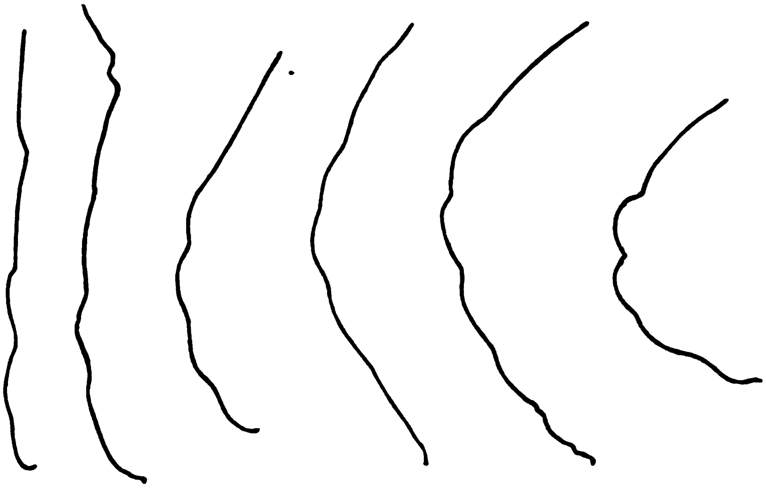
The axis of any canal is a line drawn through the centre of the canal. The axis of a cylinder, therefore, must be a straight line; the axis of a circular canal must be a circular line; and the axis of a curved canal, a curved line. The most superficial inspection of the pelvic cavity shows that the canal is a curved canal; it is evident, therefore, that the axis of the pelvic canal must be a curved line. Closer inspection shows that the curve is entirely due to the curve of the sacrum and coccyx, and that if these bones were straight instead of curved the pelvic canal would be, practically, cylindrical.

We may state, therefore, in a general way—the proposition is so simple that any can comprehend it—that the axis of the cavity of the pelvis is a curved line passing through the centre of the pelvic canal, and parallel to the face of the sacrum and coccyx; in other words, the axis of the pelvic canal is a curved line *identical* in its curvature with the curve of the hollow of the sacrum and coccyx. When we examine a number of sacral bones we shall find that no two are alike in their curvatures: some are nearly straight, some curved almost to deformity: between these two extremes there will be found every shade of different curve. *Hence it follows that the axis of the pelvic canal is not a fixed mathematical curve, but is really a line differing in each female, and de-*

*pending absolutely on the curvature of each individual's sacrum and coccyx.*

*The Diameters of the Cavity.*—The *anterior depth of the cavity*, from the top of the symphysis pubis to the edge of the subpubic ligament, is one inch and a half. The *posterior depth*, from the promontory of the sacrum to the point of the coccyx, is four and a half to five inches. The *lateral depth*, from the tuberosity of the ischium to the linea ilia, is three and a half inches. The antero-posterior diameter of the superior strait, as we have already seen, is four inches. From the lower edge of the subpubic ligament to the promontory of the sacrum is four and a half inches. This diameter can be usually readily measured in the living female, so that by deducting a half inch we can approximate to the true length of the antero-posterior diameter of the superior strait —a matter of no little importance in estimating the extent of deformities of the pelvis. From the subpubic ligament to the *hollow* of the sacrum is four and three-quarter inches. The *oblique* diameter of the pelvis is measured from the tuberosity of the ischium of one side to the sacro-iliac symphysis of the opposite side at the superior strait; it is six inches. The *height* of the *arch of the pubis* is two inches. The limbs of the arch, formed by the ischio-pubic rami, are two and a half inches long.

FIG. 228.

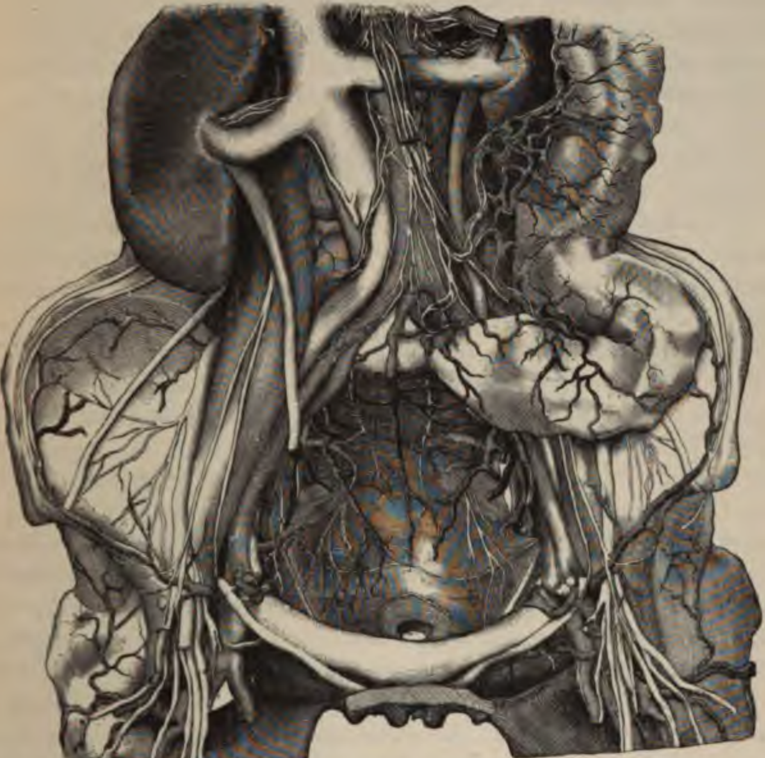


Impressions of Pelves, from specimens in the Medical Museum of the University of Pennsylvania, showing the difference in the sacral curves.

## THE PELVIS COVERED BY THE SOFT PARTS.

It is not sufficient to study the bony pelvis alone, however, if we wish to form correct ideas of the pelvis during labor. The changes produced in the form and dimensions of the pelvis of the living female by the soft parts require our special attention.

FIG. 229.



**The Pelvis, with Soft Parts (bladder, rectum, uterus, and its appendages having been removed). (From a model in the University of Pennsylvania.)**

The superior pelvis, continuous above with the abdominal cavity, encloses and supports the mass of intestines and affords attachments by its walls to two orders of muscles, the one destined to form the enclosure of the cavity, the other filling the iliac fossa. These latter are, on either side, the iliacus internus and the psoas magnus muscles. They change both the shape and size of the superior strait, the one occupying the iliac fossa, the other descending from the sides of the lumbar vertebræ. These two muscles, surrounded and confined by their aponeuroses, form a sort of cushion on either side, and thus furnish an admirable support to the pregnant uterus, and by the elasticity of their structures protect it from the violence of shocks and jars to which it is constantly exposed.

Notwithstanding these muscles, the superior strait of the pelvis still resembles a curvilinear triangle in shape: the base, however, of the triangle is now in front instead of behind, as we studied it in the bony pelvis. The transverse diameter is diminished perhaps half an inch by these muscles; practically, however, the diminution is of no moment, since the muscles are relaxed, and thrown, as it were, to the side when the thighs are flexed, as they are during labor. The antero-posterior diameters are to a trifling degree affected by the thickness of the walls of the bladder and the uterus, as well as the tissues covering the posterior face of the symphysis and the anterior surface of the sacrum, while the location of the rectum slightly shortens the corresponding diameter.

In the cavity of the pelvis are two muscles on either side—the obturator internus and the pyramidal. Finally, the cavity is further diminished by the rectum and bladder and cellular tissue; more especially when the latter is loaded with fat. Consequently, the fœtus descends with greater difficulty in corpulent females.

The perineal strait, though open in the skeleton, is closed in the recent subject, sustaining the viscera of the pelvic and abdominal cavities. It is pierced in the median line by the urethra, the vagina, and the rectum. This fleshy floor is composed of two muscular layers. The upper layer is formed of the levator ani and coccygeal muscles on either side. The lower layer is constituted by the sphincter ani, the transversus perinei, the ischio-cavernosus, and the constrictor vaginæ muscles. The internal pudic vessels and nerves, a large amount of cellular tissue, the pelvic aponeurosis, an intermuscular aponeurosis, and the external integument complete this floor. The levator ani muscles form the foundation of this structure. Arising as they do from the inner surface of the pubis, they continue their origin from the pelvic fascia down to the spines of the ischia; spreading out in a fan-like manner, they descend, enveloping the extremity of the rectum, and are inserted into the structures of the perineum. These muscles meet almost anteriorly, allowing only an opening for the vagina. It is evident that, arising as they do from the whole anterior inclined planes of the pelvic cavity, they must continue these planes clear down to the median line of the body, and also anteriorly to the orifice of the vagina, so that thus the presenting part of the fœtus during labor plays on oblique and inclined surfaces after it has passed out of the bony pelvis.

There are certain peculiarities in the arrangement of the muscles composing the floor of the pelvis which should be noticed. They are inserted by one extremity into tendinous structures and fascia, while the fibres of most of these muscles are indistinct when compared with other muscles, and are mixed up with a considerable quantity of elastic dartoid tissue. Both of these circumstances have much to do with the possibility, without laceration, of extraordinary distension during labor; indeed, the absence of these conditions would simply render dilatation impossible.

### THE PERINEUM.

All the soft parts at the outlet of the pelvis form the *obstetrical perineum.* The extent of the perineum in its ordinary conditions is three inches; from the point of the coccyx to the anus there are one inch

FIG. 230.

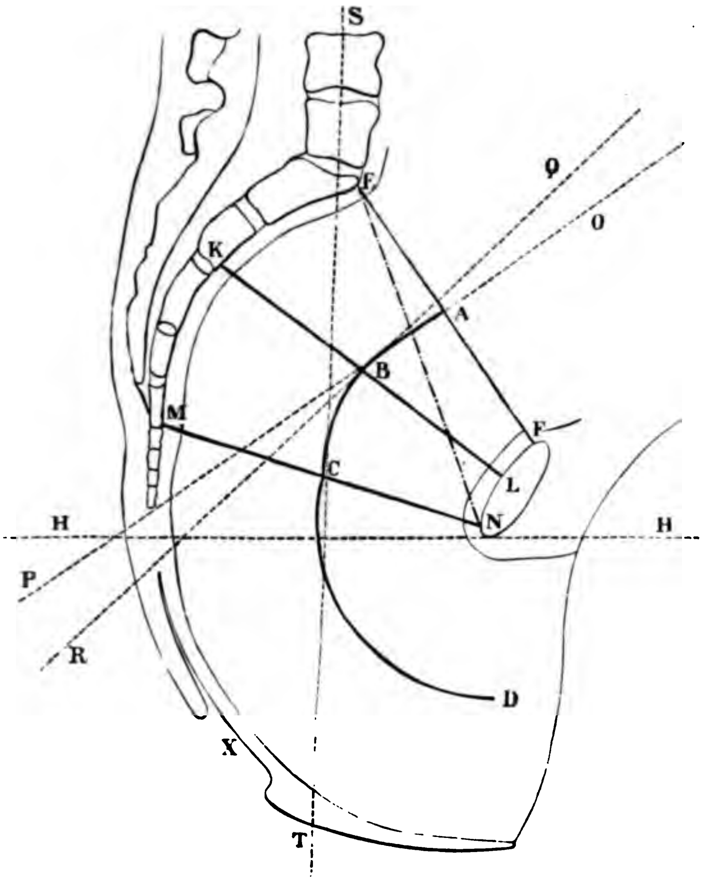


Diagram showing Axis and Planes of Pelvis: *A, B, C,* axis of developed canal of soft parts; *X*. anus as distended in parturition: *E, F,* plane of brim; *K, L,* mid-plane of cavity; *M, N,* plane of outlet: *O, P,* axis of brim; *Q, R,* axis of mid-plane; *S, T,* axis of outlet; *H, H,* horizon; *E, N,* diagonal conjugate or sacro-pubic diameter.

and three-quarters, and from the anus to the vulva there are one inch and one-quarter. As the head is about passing during labor the genital opening, the perineum becomes enormously distended, measuring four to five inches from the coccyx to its anterior margin.

It is evident that the terminal point of the pelvis, covered with soft parts, is not at the coccyx, but at the anterior margin or commissure of the perineum. It is also evident that during the latter moments of labor the perineum is greatly distended—so much so that its anterior border is pushed beyond the subpubic ligament, thus increasing to a very considerable extent the distance from the coccyx, and consequently the distance which the head has to traverse before escaping from the body of the mother.

Finally, it is evident that the head during labor disengages, not in a direction coinciding with the axis of the inferior strait of the bony pelvis, but in the direction of the axis of a plane which may be drawn from the lower edge of the symphysis pubis to the anterior commissure of the distended perineum; in other words, in the direction of a plane drawn from before backward and from above downward.

### THE PARTURIENT LINE.

If we want to understand clearly the direction followed by the child in its engagement in, and expulsion from, the cavity of the pelvis, we must add to the axis of the bony pelvis the axis of the uterus above and the axis of the distended soft parts below. This parturient line is, of course, fixed and unchangeable for the bony canal, and variable for the uterus above and the distended soft parts below. Above we meet with different varieties of uterine obliquity, which may affect greatly the engagement of the presenting part. Below, the labor is equally or more influenced by the mobility of the coccyx and the dilatability of the perineal structures.

The axis, then, of the canal formed at the latter moments of labor by the distended perineal structures is a curved line continuous with the curved line of the axis of the bony pelvis. The curvature of this line is due to the extent of the perineal bulging and stretching, and consequently varies in every case.

It must be borne in mind that in all the above descriptions of the axes of the planes and cavity of the pelvis the individual has been supposed to be erect. Should she lie upon her back, the plane of the superior strait, instead of looking upward and forward, would be turned upward and backward; the plane of the inferior strait would look directly forward; while the plane of the terminal outlet formed by the distended perineum would look forward and upward.

## The Fœtus.

The fœtus at term is from eighteen to twenty inches in length. The bones are only partly ossified, and hence admit of great compression and exhibit great flexibility. The diameters of the fœtal body, though as large as, or even larger than, those of the head, are much more compressible. Thus, from one shoulder to the other, the *bis-acromial* diameter is about four inches, but is readily reduced by pressure to three and a half, or even to three, inches. The dorso-sternal diameter, from the spinous processes of the dorsal vertebræ to the sternum, is three inches, easily reduced to two and a half inches. The transverse diameter of the hips, or bis-iliac diameter, is about three inches. The antero-posterior diameter of the child's pelvis is about two and a half inches; when the thighs are flexed on the abdomen, however, the antero-posterior diameter, including the thickness of the flexed extremities, may be considered as three inches.

The head is the most important part to be studied. Its shape is ovoid; it has two extremities—the occipital and the mental, the occipital being the larger part. The bones of the head entering into the composition of the face and base of the head are almost perfectly ossified at term; they are, in consequence, incompressible, and thus during labor the important nerves of special sense and ganglia at the base of the brain are protected from pressure. The bones of the cranial vault, however, are very imperfectly ossified at term. They are connected by what are called sutures or commissures, allowing of considerable mobility, or even of overlapping, of the adjoining bones, and thus increasing greatly the compressibility of this portion of the head. I shall assume that the reader is familiar with the bones, sutures, and fontanels of the fœtal head, and shall not occupy space by describing them.

We must study on the fœtal head several circumferences which must be well understood, since in different presentations different circumferences offer their diameters to the diameters of the pelvis. When the child's head is perfectly flexed we have it presenting its most favorable circumference. This circumference is represented by a line which, starting at a point midway between the occipital protuberance and the occipital foramen—in other words, the nape of the neck—passes over the parietal protuberances and terminates at the posterior point of the anterior fontanel. We term it the *cervico-bregmatic* circumference; sometimes it is called the occipito-bregmatic or the suboccipito-bregmatic circumference. We consider in this circumference two diameters. The biparietal diameter, the largest transverse diameter of the head, measured from one parietal protuberance to the other, is three inches and a half. The cervico- or occipito-bregmatic diameter is measured from the point midway between the occipital foramen and the occipital protuberance to the posterior margin of the anterior fontanel; it is three inches and a half. In other words, the cervico-bregmatic circumference of the child's head is a circle, and its two diameters are each three and a half inches. The circumference itself measures about ten and a half inches. This circumference bounds the oval of the posterior extremity of the head, the summit of which is the *vertex.*

There are various definitions given to the term "vertex." By some the anterior fontanel is so called; some apply it to the posterior fontanel; while, again, the term is also used to designate the space between the anterior and posterior fontanels. The word "vertex" means the "top of a hill," the "point of a cone;" hence the vertex of the head should be the top of the head. Now, the head in natural labor is flexed, and consequently the posterior fontanel is at this time its highest point. Hence it seems that the proper definition of the term "*vertex*" in obstetrics should be *that part of the head immediately around the posterior fontanel.* When the word "*vertex*" is used in the following descriptions, it will be employed to indicate the posterior fontanel and a small circle of about one inch in diameter of which the fontanel is the centre.

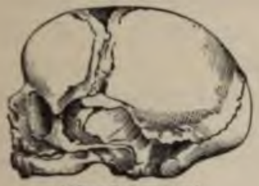
When the head offers at the superior strait only partially flexed and at right angles with the spine, a new circumference must be studied. We call it the *horizontal* or the *occipito-frontal* circumference. This circumference is measured from the occipital protuberance over the parietal protuberances to the os frontis. We study two diameters—the occipito-frontal diameter, measured from the occipital protuberance to the os frontis, which is four inches; and the biparietal diameter, which is three and a half inches. The horizontal circumference measures twelve inches. The *anterior* fontanel is the lowest part in this presentation.

When the head becomes still more extended, so as to bring the top of the forehead as the most dependent part, we have a circumference offering which we call the *sagitto-mental* or *parieto-mental* circumference. This circumference is measured from the middle of the *sagittal* or *biparietal* suture to the point of the chin. It measures twelve and a half inches. It has two diameters—the *sagitto-mental* or *parieto-mental* diameter: measured from the middle of the sagittal suture to the chin, it is four inches and a half; and the biparietal diameter, which is three inches and a half. In this presentation the cervico-frontal diameter is in the axis of the superior strait; it is measured from the nape of the neck to the top of the forehead, and is four inches: by pressure it can be reduced to three and a half inches.

When the head offers at the superior strait in a condition of complete extension, the circumference involved is called the *facial* circumference. The facial circumference is measured from the top of the forehead to the chin; the root of the nose is the centre of this circumference. There are two diameters: one, the fronto-mental, is measured from the top of the forehead to the chin, and is three inches; the other, the transverse diameter, is called the bimalar, and is two and a half inches, though if the child's face is large and fat the bimalar diameter may be three inches.

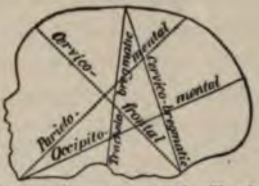
The facial circumference, however, is not the only circumference to be studied in face presentations, since as the face descends the circumference measured at the middle of the head must be involved. This circumference we call the trachelo-bregmatic, and it is measured from the anterior edge of the foramen magnum to the posterior part of the anterior fontanel. There are two diameters: one, the *trachelo-bregmatic* diameter, is measured from the anterior edge of the foramen magnum to the posterior part of the anterior fontanel; it is three and a half inches; the other, the biparietal diameter, is three and a half inches. The trachelo-bregmatic circumference measures ten and a half inches, and both in its diameters and circumference is identical with the cervico-bregmatic circumference, which we have already studied.

Fig. 231.



Side of the Head.

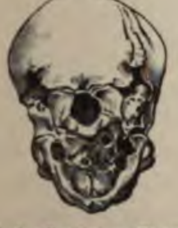
Fig. 232.



Lateral Diameters of the Head.

In presentations of the pelvic extremity of the child the head often offers at the superior strait more or less extended, and we are obliged to consider the circumference of the base of the head—the *occipito-mental* circumference, measured from the occipital protuberance to the chin. The diameters of this circumference are the *occipito-mental*: from the occipital protuberance to the chin, the longest diameter of the

Fig. 233.



Inferior Region, or Base of the Head.

Fig. 234.

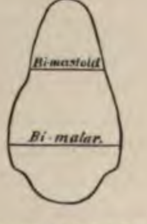
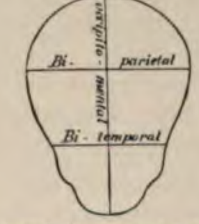


Diagram of the Base of the Head.

Fig. 235.



Actual Obstetric Extent of the Base of the Head.

head, it is five inches; and the biparietal, three and one-half inches. The occipito-mental circumference measures thirteen and a half inches.

In presentations of the base of the head we also have involved the bimalar diameter, two and a half inches, and the bimastoid diameter, two inches. In any difficult labor strong compression may reduce the transverse diameter, the biparietal, to three inches, and may so elongate the head as to increase the occipito-mental diameter to six or seven inches.

Before concluding our inspection of the fœtus we should notice the articulations of the head with the spinal column. The foramen magnum is not at the centre of the base of the head, but behind the centre; hence that portion of the head anterior to the foramen magnum represents the long arm of the lever, and consequently, when the head offers in labor and equal forces of resistance are impressed on its anterior and posterior parts, flexion of the head, so essential to an easy labor, is secured as a necessary and constant result.

The nature of the articulation of the head with the vertebræ, and the movements possible, are to be remembered. The occiput is connected with the atlas by a close union admitting only of flexion and extension—movements in the fœtus far more extensive than in the adult. The articulation of the axis with the atlas, being ginglymoid, only permits rotation, and this is limited to a quarter of a circle in either direction. Hence it must always be borne in mind in obstetrical manipulations that a forced rotation of the head, to a greater extent than a quarter of a circle, exposes the child to the danger of dislocation of its cervical vertebræ.

In conclusion, it is not uninteresting to consider the influence that sex, race, civilization, and education have in increasing the size of the fœtal head, and, consequently, the difficulties and dangers of labor.

The head of the male fœtus is larger, as a rule, than the head of the female, the excess being about a half inch in the cervico-bregmatic circumference; but this half inch excess is quite sufficient to make a serious difference in the chances and dangers of labor both to mother and child. Sir James Simpson[1] gives a number of very interesting tables on this subject. He shows that a much greater number of mothers die from parturition and its immediate consequences in giving birth to male than female children, and that a much larger number of males die during labor than females, the proportion of stillborn boys to stillborn girls being as 151 to 100. Of children born alive, more males than females suffer from the morbid states and injuries resulting from parturition.

Race, civilization, and education also have a marked effect on the fœtal head, modifying not only its size, but also its shape, and should always be taken into consideration in forming a prognosis in any particular case where these elements are involved.[1]

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[1] See *Edinburgh Medical and Surgical Journal*, Oct., 1844.

## DIRECTION OF THE FORCES.

In studying the mechanism of labor we must bear in mind the direction in which the expelling forces act in natural labor. These forces, which consist of the contractions of the uterus, aided, during the second or expulsive stage of labor, by the contractions of the diaphragm and abdominal muscles, act in *natural* labor in the direction of the axis of the superior strait. In labor there seems to be a natural disposition on the part of the woman to bend forward—a movement that brings the axis of the body to coincide more or less with the axis of the superior strait, and thus tends to secure the maximum results from the parturient efforts.

## PRESENTATION AND POSITION.

In contemplating the fœtus and its possible relationships to the pelvis it is evident that it can pass easily through the cavity *only* when it offers by one or the other extremity or pole of its long axis. It is equally evident, however, that any other part may offer at the superior strait, and, as the mechanism of labor must depend on the part offering, we must, before entering on the subject of the mechanism, define presentation and position.

PRESENTATION.—By "*presentation*" *we mean that part of the fœtal ellipse that offers toward the centre of the superior strait.* We must not confound (as is constantly done) the term "*presentation*" with the word "*position*."

POSITION.—By "*position*" *we mean the varying relationships which the same presenting part may bear to different parts of the superior strait.* Thus the child is offering by its head; it is a *presentation* of the head. The occiput is turned to the symphysis pubis; it is an occipito-anterior (occipito-pubic) *position*. The occiput is turned to the sacrum; it is an occipito-posterior (occipito-sacral) *position*. Position, the varying relationships which the same presenting part may bear to the different parts of the superior strait.

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[1] In a recent paper ("Midwifery among the Aborigines," *Prov. Med. Journ.*, Jan., 1886) Dr. Parker says: "Rupture of the perineum seems to be a rare occurrence among the full-blooded Indians, but among the more civilized half-breed women I was told that it was becoming quite common." This can be ascribed, of course, to nothing else than the increasing size of the fœtal head.

Surgeon Parahh of India (*London Lancet*, April 10, 1886) measured large numbers of fœtal skulls of European, Persian, Parsee, Siamese, and Hindoo races, and found the measurements to increase in direct ratio to the height of civilization to which the different races had attained.

We study labor under two divisions—natural labor (or eutocia) and preternatural labor (or dystocia).

In natural labor the process is accomplished with safety to the mother and the child, without any great danger or difficulty, and without assistance. Natural labor implies that the mother is in a good anatomical and physiological condition; also, that the child does not exceed the normal as to its size or the size of its parts; and, finally, that the *presentation* and position are favorable. Now, we have just seen that there are but *two* presentations possible in natural labor—viz. presentation of the head and presentation of the pelvic extremity of the child. Experience shows that head presentations are by far the more common; hence we will begin with head presentations.

## PRESENTATIONS OF THE VERTEX.

All statistics show that presentations of the head vastly exceed in frequency all other presentations, the proportion being about 95 or 96 head presentations in every 100 cases of labor. Under the term "head presentations" are included all presentations of the cephalic pole of the fœtus, whether they are presentations of the vertex, of the face, or of any other part of the head. We shall presently see, however, when we investigate the causes of presentation and position, that the common and natural form of head presentation is presentation of the vertex—*i. e.* presentation of the *flexed* head—and that all other forms of head presentation are the results of causes easily understood, and which do not belong to typical natural labor. We say, then, that *vertex* presentations are the common and natural forms of head presentations. A striking fact in vertex presentations is that the great majority have the same position; that is, the great majority have the occiput turned in front and to the left side—left occipito-anterior position. The next most common position in vertex presentations is with the occiput turned behind and to the right side. Naegele says that in every 100 cases of vertex presentation 70 have the occiput turned in front and to the left side, and 30 have the occiput turned behind and to the right side, and that all other positions are very rare and altogether exceptional.[1]

## THE FŒTAL ELLIPSE.

At the full period of gestation we find the fœtus folded in the cavity of the uterus in a very peculiar and characteristic attitude. The head is flexed; the feet are bent up in front of the legs; the legs are strongly flexed on the thighs; and the thighs are applied to the anterior surface of the abdomen. The knees are separated from each other, but the

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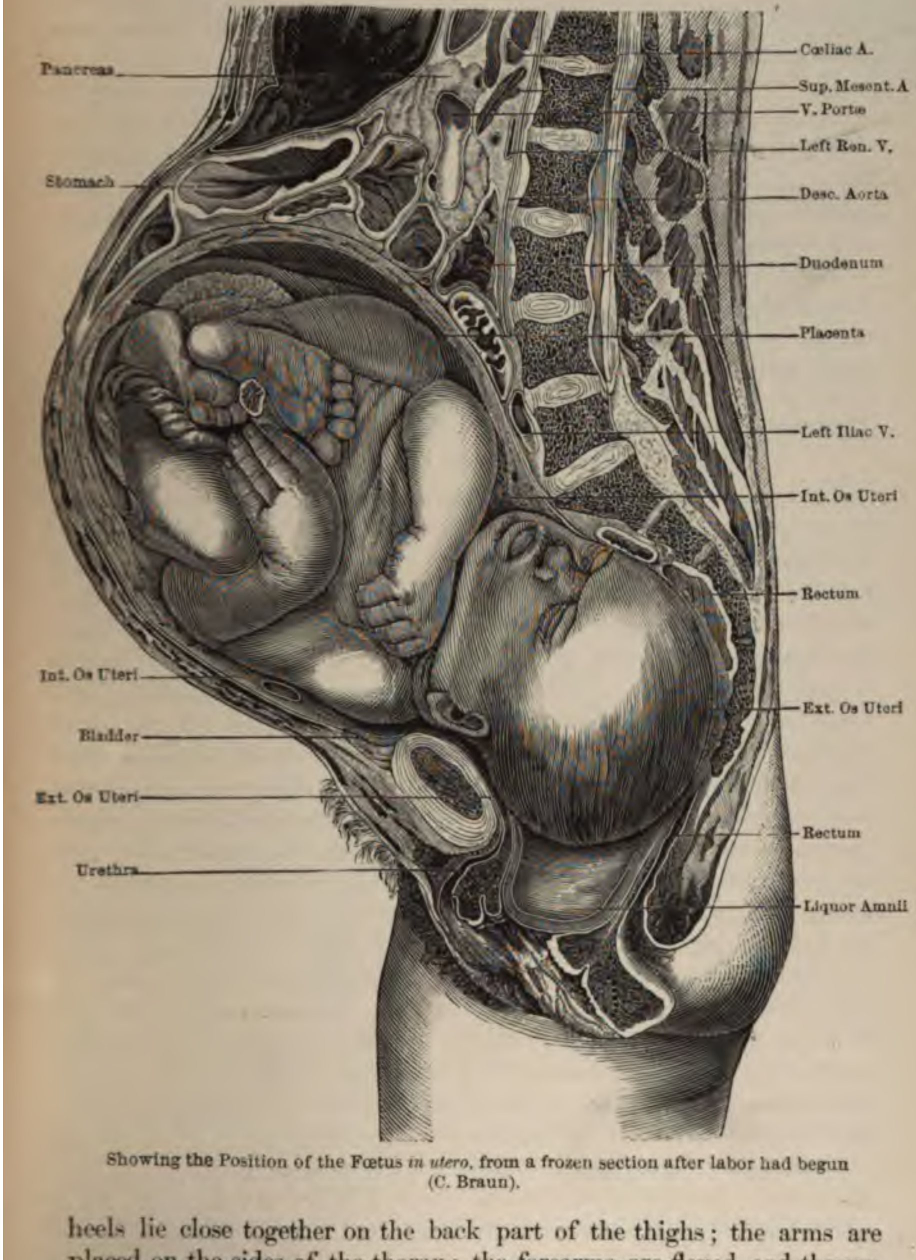
[1] Franz Carl Naegele, professor of midwifery at Heidelberg, essay on the *Mechanism of Parturition*, published in 1818. His son, Herman Franz Naegele, succeeded him in his chair, and wrote an admirable treatise on obstetrical auscultation in 1838.

FIG. 236.



Showing the Position of the Fœtus *in utero*, from a frozen section after labor had begun (C. Braun).

heels lie close together on the back part of the thighs; the arms are placed on the sides of the thorax; the forearms are flexed and thrown across the sternum, so as to receive, as it were, the chin between the hands. The fœtus, thus folded on itself, constitutes a nearly ovoid mass; the larger extremity, represented by the breech, is turned toward the fundus of the uterus, while the smaller, formed by the head, is directed downward. This ovoid mass is called the fœtal ellipse. Its long diameter is about eleven inches.

This ovoid mass occupies the cavity of the uterus, which is also of a corresponding ovoid shape. The fundus of the uterus at term represents the largest part of the egg. The length of the cavity is about twelve and a half inches; the widest transverse diameter, toward the fundus, is eight inches; while lower down, near the os uteri, the transverse diameter is only four inches.

The normal position of the fœtus in the cavity of the normal uterus is certainly paradoxical and peculiar; and the questions at once suggest themselves, What are the causes of this, the normal, attitude? and, What are the causes of all departures from it?

## THE ATTITUDE AND POSITIONS, NATURAL AND PRETERNATURAL, OF THE FŒTUS IN UTERO.

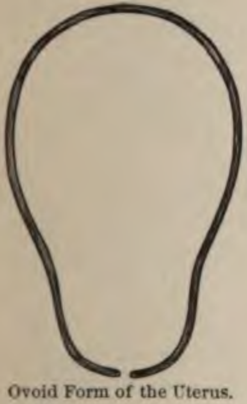
The common opinion formerly was that the normal attitude of the fœtus in utero at term—an attitude which placed it upside down in the uterine cavity—was due to the action of gravity. The theory was that the fœtus, suspended by its cord and floating in the liquor amnii, obeyed the law of gravity, and the head, being the heaviest part, descended to the lowest part of the cavity, while the lighter breech occupied the fundus. This theory certainly is very plausible and seems to explain the fact completely. It has, however, one fatal objection—an objection which applies to many other most specious theories in science and philosophy; and that is, that there is not one word of truth in all of its apparently legitimate assumptions. Each premise is false; each conclusion, therefore, must be equally false. In the first place, the child is not suspended by its cord, since from an early period in gestation the cord is longer than the long diameter of the cavity. Secondly, during the latter months of gestation it does not float in the amniotic cavity, the total amount of liquor amnii at term seldom exceeding one or two pints. Finally, the head of the fœtus at term is not its heaviest part. Any one can readily test this assertion by placing a recent stillborn infant in a tub of water: should this be done, it will be found that, as the body sinks, the back or shoulder will generally reach the bottom first.

Dubois, after proving the worthlessness of this popular opinion, maintained that the true cause of the position of the fœtus in utero was the instinct of the fœtus itself. He held that, in consequence of an unerring instinct, the fœtus assumed that position in the cavity of the uterus which contributed most to the ease and safety of its birth. In this way he explained the position of the fœtus in animals, in which the lowest part of the womb does not correspond with the neck, as in the upright human female, but rather with the fundus; nevertheless, the fœtus in animals generally presents by its head. This theory of Dubois certainly is a great advance over the theory of gravity. Yet, though looking in the right direction toward the truth (which the gravity theory never did), it can scarcely be said to be satisfying.

To Sir James Y. Simpson of Edinburgh belongs the credit of suggesting the only completely satisfactory and scientific theory on this most interesting and important subject—a theory that explains not only the usual position of the fœtus, but also every aberration and exception. In other words, Simpson's theory gives us the clearest explanation of every presentation and position possible for the fœtus in utero. Simpson's paper on this subject is a long one, but will well repay the time spent in reading it. It can be found in the *Edinburgh Monthly Journal of Medical Science* for January, 1849.

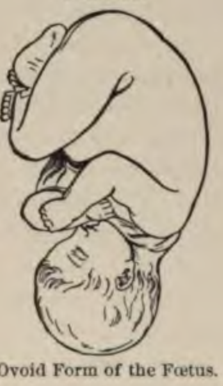
Simpson's theory is that the position of the fœtus in the cavity of the uterus at the full period of gestation is due to the action of several causes. In the first place, it is due to the shape of the *normal* fœtal ellipse at term; secondly, to the shape of the *normal* uterine cavity at term; and, finally, it is due to the automatic or reflex movements of the fœtus (Dubois' instinct), which automatic movements cause the fœtus to assume that position in which its own peculiar shape will accommodate itself to the peculiar shape of the containing cavity, and thus it is enabled to enjoy the greatest comfort and latitude of movement; and it is not only brought into this desirable relation, but it is subsequently maintained in it, by these reflex actions.

FIG. 237.



Ovoid Form of the Uterus.

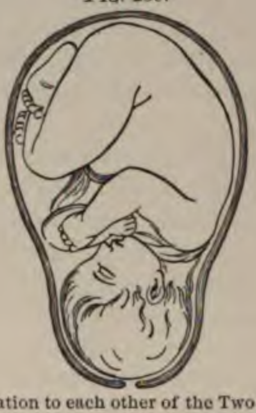
FIG. 238.



Ovoid Form of the Fœtus.

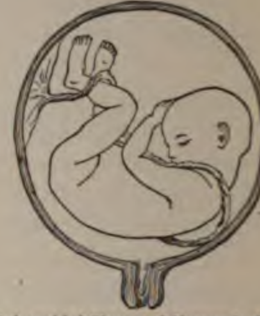
Before the end of the sixth month of gestation the cavity of the uterus is spherical, and not egg-shaped; it contains, relatively, a large amount of amniotic fluid. The fœtus also at this period is not folded up in the peculiar manner that characterizes it at term; it is also comparatively small; that is, its long axis is shorter than the transverse diameter of the uterine cavity; consequently, before the end of the sixth month the fœtus assumes every position that accident or circumstance may occasion—now on its head, again on its side or breech or back or abdomen.

FIG. 239.



Adaptation to each other of the Two Ovoids.

FIG. 240.



Spheroidal Shape of Uterus before Sixth Month.

After the sixth month the shape of the uterine cavity *gradually* changes, until at term it presents its characteristic ovoid or pear shape. The amount of liquor amnii relatively decreases as gestation advances. Coincident with these changes the fœtus *gradually* becomes folded up and becomes the ovoid or pear-shaped mass seen at the end of gestation. As the long diameter increases after the sixth month, the child presently can no longer change its position, but its attitude becomes fixed. Now it is gradually brought into this attitude, and maintained in it, by its own automatic movements. The child is uncomfortable in any position save that in which it is least pressed upon. Hence when the alteration in shape of the uterine cavity causes uncomfortable pressure on any part of the fœtal surface, *automatic* struggles ensue (the *instinctive* movements of Dubois), which are kept up until the necessary adjustments are secured. Should any maternal movements cause the proper adjustment to be disturbed, automatic struggles immediately take place, and last until the fœtus again secures a comfortable position.

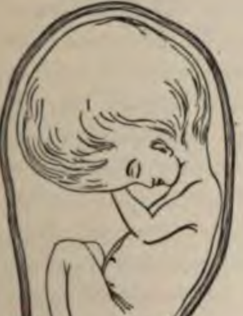
That this theory of Simpson's is the true theory is proved by a great variety of well-known facts. In the first place, all statistics show that in premature labors before the end of the sixth month—in other words, before the position of the fœtus has become fixed—the child offers by any part that may happen accidentally to be at the mouth of the uterus, as by the breech or trunk.

Again, alter any one of the three causing conditions—viz. the shape of the uterus, the shape of the fœtal ellipse, the automatic movements of the fœtus—and the normal position is apt to fail. Thus, the child is placed in its peculiar position by its automatic movements; these movements also maintain it in this position. Hence, if the fœtus should die some time before term, these automatic movements necessarily will be lost; it becomes a mere inert mass, and a malpresentation—depending on the many accidental conditions affecting it prior to and at labor—is often the result.

Dr. Collins' statistics, based on 16,659 cases of labor, show a breech presentation once in every 62 *living* births (1 in 62), but in *putrid* children (children dead a long time before labor, and where, consequently, there were no reflex movements to maintain the normal position) a breech presentation occurred once in every 6 labors (1 in 6). The same statistics show 1 shoulder or trunk presentation in every 555 living children (1 in 555), while, in putrid children, 1 trunk presentation occurs once in every 88 labors (1 in 88).

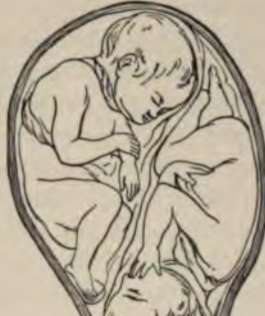
Again, when from disease the *shape* of the fœtus is changed from the normal one, the very causes, which in normal cases secure a normal presentation, will in such abnormal modifications cause an abnormal presentation. Dr. Simpson gives many illustrations, but intra-uterine hydrocephalus forms one of the most striking. In such cases, when the cranial enlargement is very great, the head becomes the largest part of the fœtal ellipse, and consequently the very reflex movements, which in ordinary cases place the larger breech at the fundus, now bring the abnormally enlarged head to the same position. All experience shows that breech presentations are very common in cases of intra-

FIG. 241.



Hydrocephalic Fœtus.

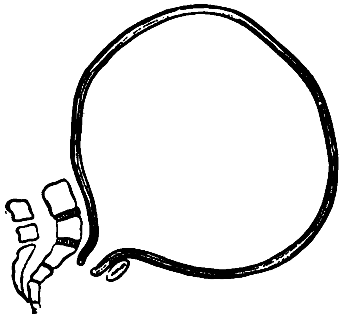
FIG. 242.



The Uterine Cavity Distorted by Twins.

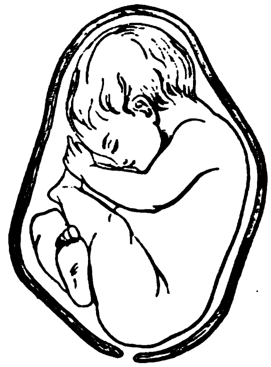
uterine hydrocephalus; and the reason why they are not far more common is that the hydrocephalic enlargement does not take place, to any modifying extent, until after the child has become so fixed in its position that the shifting somersault cannot take place.

FIG. 243.



Abnormal Shape of Uterine Cavity, the result of deformed pelvis (Simpson).

FIG. 244.



A Breech Presentation, the result of abnormal shape of the uterine cavity (Simpson).

Again, in accidental or permanent modifications in the *shape of the uterine cavity* abnormal presentations are very common at labor. In this way we are able to explain the malpresentations occurring in labors complicated by fibroid tumors of the uterus, deformities of the brim of the pelvis, placenta prævia, excess of liquor amnii, and other abnormal conditions.

Thus, cases are reported where the same woman in all of her labors, amounting to six, eight, ten, or more, had the child always presenting by the breech. In such instances undoubtedly there was some marked deviation in the shape of the uterus, in consequence of which its most roomy part was that near the os uteri; and hence the very same causes which usually place the breech at the more capacious fundus, in these exceptional modifications of the uterine cavity place it at the more capacious lower part of the organ.

Cases are reported where the same woman in all of several labors had the child offer by its trunk. In instances of this sort the deformed uterus had for its longest diameter the transverse diameter; consequently the fœtus fitted best and was most comfortable with its long axis corresponding to the long axis of the abnormal uterus in which it was placed, and a trunk presentation was the result.

In addition to these causes of presentation, which we may call the natural causes, there are undoubtedly certain accidental conditions which modify or alter both presentation and position. One of these accidental circumstances is an accident happening to the mother (as a fall) about the time the fœtus is assuming its normal attitude in the uterine cavity in the sixth month; that is, about the time its long axis is almost equal to the transverse diameter of the uterine cavity. Under such circumstances the child may suddenly be turned by the shock, and, unless a shaking up, equalling or exceeding in violence that which has placed it in its uncomfortable position, should happen, it will be compelled to remain in it, in spite of all its automatic struggling, and a breech presentation will be the consequence. I have no doubt that almost every case of breech presentation not due to modifications in shape of fœtus or uterus is the result of accidental causes.

Finally, obliquities of the uterus, before and during labor, are undoubtedly potent accidental factors of many kinds of malpresentation. In such cases the fœtus, though placed normally in the uterine cavity, is urged by the contractions of the oblique uterus, not in the direction of the axis of the superior strait, but more or less obliquely to the plane of the superior strait. Hence the head, in some instances, slips past the pelvic opening entirely, and a trunk presentation is the consequence; or the head, striking on the edge of the superior strait, is arrested, and a malpresentation of the head may result, as a face, or brow, or side of the head.

In summing up this very interesting and important subject, we conclude that the normal position of the normal fœtus in the normal uterus at term is that where the head is at the os uteri; in other words, a vertex presentation is the, strictly speaking, only absolutely normal presentation; that this presentation is due to the causes which we have just studied; that all departures from this presentation are the results of the modifications of the causes occasioning it; and that thus we can explain most clearly and satisfactorily every possible presentation that can offer during labor. The action of these causes, and of others easily understood, enables us readily to comprehend why but two positions of presentation of the vertex are, strictly speaking, normal—viz. the left occipito-anterior and the right occipito-posterior.

The anterior part of the uterine cavity at term is the most capacious and best fitted to the posterior part of the fœtal ellipse, while the posterior wall of the uterus is more or less pressed upon by the projecting lumbar vertebræ, and thus the posterior part of the cavity is best fitted to the anterior plane of the folded fœtus. It is in consequence of these conditions that the child usually offers with its back in front; should, however, from any cause, the cavity of the uterus not present the peculiarities just referred to, but possess a perfect pear-shaped outline, then the back of the child may look in any direction, back or front or to either side. In any event, the presence of the sigmoid flexure of the colon, and the presence of the rectum on the left side, with the accumulations common to them, and the frequent passage of these accumulations, furnish ample reason why the head, whether the back be in front or behind, should be compelled to assume an oblique position at the superior strait, and, consequently, ample reason why in a strictly normal fœtus, in a strictly normal cavity at term, the strictly normal position should be the left occipito-anterior or the right occipito-posterior.

## MECHANISM OF PRESENTATIONS OF THE VERTEX.

As presentation of the vertex is the normal presentation, we will begin our discussion of the mechanism of labor with the mechanism of vertex presentations.

Authorities differ greatly as to the number of positions to be described in vertex presentations. Some describe only two—viz. the occiput to the left side (first position), and the occiput to the right side (second position). Others describe four, six, and eight positions. Really, the whole matter is an arbitrary arrangement, and, when we have clear ideas on the subject of presentation and position, we may take two or fifty positions (should we prefer to study so many) at the superior strait.

I shall follow the arrangement of Hodge, and shall take six positions at the superior strait. The points of location of these six positions are—the four inclined planes of the pelvic cavity, the symphysis pubis, and the promontory of the sacrum. Some deny the possibility of the positions to the sacrum and pubis. Undoubtedly, they are rare: even when they do exist at the beginning of labor, the posterior projection of the interpubic pad in front and the promontory of the sacrum behind cause the round and smooth head, among the earliest changes of labor, to assume the normal oblique position at the superior strait. Still, these positions sometimes persist, and occasion difficulties which we should recognize.

Following Hodge, we will take six positions of the vertex. Three of these positions have the back of the head turned in front; hence we call them occipito-anterior positions. Three have the back of the head turned behind (occipito-posterior positions).

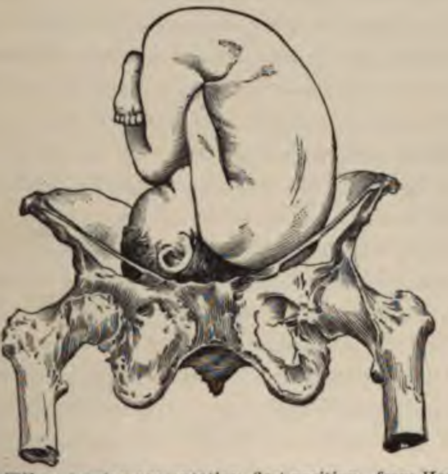
We call that position the *first* which is the most common of all positions—viz. where the occiput is in front and to the left side; the other positions are designated by terms, as is this the first, entirely arbitrary, and which are usually intended to indicate the relationship between the head and the pelvic cavity.

POSITIONS OF VERTEX PRESENTATIONS.—First position, left occipito-anterior, occiput to the left anterior inclined plane; second position, right occipito-anterior, occiput to the right anterior inclined plane; third position, occiput to the symphysis pubis; fourth position, right occipito-posterior, occiput to right sacro-iliac symphysis; fifth position, left occipito-posterior, occiput to left sacro-iliac symphysis; sixth position, occipito-sacral, occiput to the promontory of the sacrum.

MECHANISM OF THE FIRST POSITION.—*Left Occipito-anterior, Occiput looking to any part of the Left Anterior Inclined Plane.*—In this position the back of the child looks in front and to the left, its anterior plane behind and to the right. One hip, one shoulder, one parietal protuberance look in front and to the right side; the others, behind and to the left. In these descriptions I shall not refer to any part as the right or left part, as these designations are always confusing, but as the anterior or posterior part; thus, the anterior or pubic shoulder, the posterior or sacral hip, etc., etc.

Before entering on the description of the changes occurring in the mechanism of the first position of the vertex, it may not be out of place to remark that when the student understands thoroughly the mechanism of labor in vertex presentations he can readily comprehend, without the slightest difficulty, the mechanism of labor in all presentations and positions. Perhaps I can give a clearer idea of my meaning by comparing the mechanism of labor in vertex presentations to a tune, of which tune the mechanism of labor in all other presentations is the same, with variations. If the student shall get the harmonies of this simple (and beautiful?) tune fixed in his memory, he will have little difficulty in adapting the self-evident variations to any presentation offering.

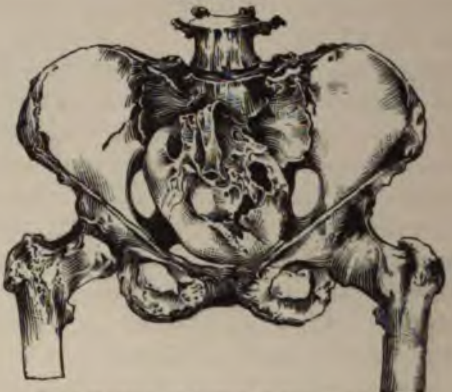
FIG. 245.



Fœtal Ellipse (vertex presentation, first position—from Hodge).

At the superior strait, and before the bag of waters ruptures, the head (in a first position of vertex presentation) offers only *partially* flexed, presenting really the occipito-frontal circumference, with its longer diameter, instead of the cervico-bregmatic circumference. When, however, the bag of waters ruptures and a portion of the liquor amnii escapes, the walls of the uterus come in direct contact with the body of the child and force it down into the pelvic cavity. The head, meeting with resistance, becomes perfectly flexed. This flexion of the head under these circumstances is readily understood when we bear in mind the position of the foramen magnum at the base of the skull—that it is behind the centre; hence that portion of the head anterior to the spinal articulation represents the long arm of the lever, and when an equal force of resistance is applied to the anterior and posterior portions of the head, flexion must result; and this flexion becomes perfected as the resistance increases, until a complete vertex presentation is secured, and the cervico-bregmatic circumference fairly offers to the diameters of the superior strait or cavity of the pelvis. Hence the first effect of uterine contractions after dilatation of the os is to complete the flexion of the head, and thus the first effect of uterine contraction is to perfect the fœtal ellipse.

Fig. 246.



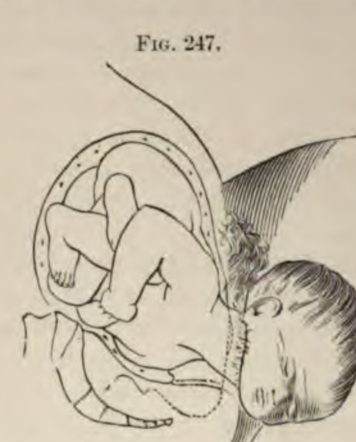
First Position of Vertex at Superior Strait.

We may call the flexion, thus secured, *adaptation*, since it causes the fœtal ellipse to offer its most favorable diameters to those of the pelvis. When we come to study the mechanism in other presentations we shall see an attempt to secure similar results in every instance. In other words, Nature's first effort seems to be to attempt to bring the presenting part to offer, if possible, by its smallest and most favorable diameters. The first effect, then, of uterine contractions, after dilatation of the os, in all presentations, is *adaptation*, and *adaptation* in vertex presentation, as we have seen, means *flexion*.

The second effect is to force the head to engage and descend, with the plane of its presenting diameters (*more* or *less*) parallel, when at the superior strait, with the diameters of the plane of the strait. Hence we have the cervico-bregmatic diameter (3½ inches) *more* or *less* in relation with the left oblique (5 inches), while the biparietal diameter (3½ inches) is *more* or *less* in relation with the right oblique diameter (5 inches). Here, in order to avoid future misconception, we will designate the oblique diameter, measured from the left acetabulum to the right sacro-iliac symphysis, the *left oblique diameter*, and the diameter measured from the right acetabulum to the left sacro-iliac symphysis the *right oblique diameter*. The expression "the cervico-bregmatic diameter in one oblique, and the biparietal diameter in the other oblique," though sufficiently accurate for the purposes of description, is not absolutely so. Thus, for example, the posterior pole of the biparietal diameter may be in relation with any part of the left posterior inclined plane, the anterior pole necessarily bearing corresponding relations with the right anterior inclined plane; hence the relationships of diameters may vary, and we may have 3½ inches offering to the oblique (5 inches) or the transverse (5¼ inches). Moreover, the cervico-bregmatic circumference is not mathematically parallel with the plane of the superior strait: the head actually engages and descends somewhat obliquely, so that the anterior parietal protuberance is a little lower than the posterior. While admitting this to be the mathematical fact, yet for all practical purposes, as well as for the convenience of description and illustration, we shall assume the head as offering fairly the plane of the cervico-bregmatic circumference to the plane of the superior strait. The head thus forced to engage (3½ inches in each direction), offering to 5 or 5¼ inches, meets with no obstruction, and readily descends into the cavity and reaches the floor of the pelvis, the occiput playing on the left anterior inclined plane, and the forehead looking toward the right posterior inclined plane. Reaching the floor, the occiput can move no longer in the direction of the axis of the superior strait; it is arrested in that direction by the floor, and a new movement takes place; which movement we call *rotation*. The smooth, round occiput, meeting the smooth inclined pelvic surfaces, slides downward, forward, and inward, until at last the nape of the neck gets beneath the arch of the pubis, and the forehead and face look toward the hollow of the sacrum.

We may notice the diameters now offering to the diameters of the inferior strait—the cervico-bregmatic to the antero-posterior (3½ inches to 4½ inches); the biparietal to the transverse (3½ inches to 4 inches), the occipito-mental, *more or less* exactly, corresponding to the axis of the strait. While the head has rotated, the body of the child, still in the cavity of the uterus, has been tightly grasped by the firmly-contracted walls of the uterus, and has not participated in the movement of the head; hence the shoulders are still oblique at the superior strait, and consequently the neck of the child is twisted. The expelling forces still acting, the occiput gets well beneath the arch of the pubis, and the back of the neck is pressed firmly against the inner face of the symphysis. The head is arrested, since a further advance of the occiput is impossible. A new movement now ensues, called *extension*. Until the moment of arrest, the occiput, in consequence of the complete flexion of the head, has received, through the spinal column, almost directly the whole force of the expelling powers. Now, being locked beneath the symphysis, its further advance is impossible, and the chin, the only part of the head that can move, under the influence of the very forces that until now caused the occiput to descend, leaving the breast of the child, against which it has been more or less pressed, sweeps through the concavity of the distending soft parts, the nape of the neck resting on the subpubic ligament as a point of support, while the chin and face describe round it, as extension proceeds, the arc of a circle from the coccyx to the fourchette, the radius of which arc is the cervico-frontal diameter (the cervico-frontal diameter, 4 inches, reducible to 3½ inches); while the occipito-mental diameter, during the whole process of extension, is more or less on a line with the axis of the canal of the distended soft parts. Finally, when extension is completed, the head is turned up in front of the symphysis, the occiput resting on the lower part of the mons. As the head passes through the inferior strait, and until its final escape, the soft parts at the outlet —*i.e.* the perineum—become enormously stretched, enough to cover the whole head. Resistance increases until the parietal protuberances pass —in other words, until the cervico-frontal circumference escapes. At this moment the anterior border of the perineum, in consequence of its own elasticity and the contraction of its muscles, slips over the face and embraces the neck. The head until this moment has been held up strongly by the distended soft parts against the mons Veneris; now, freed from their grasp, it falls by its own weight, the chin going to the anus. As soon as the head is born and free to move, the neck untwists itself, the head resumes its natural position, and consequently assumes an oblique position, the occiput going to the left groin and the chin to the right tuberosity of the ischium. This untwisting of the neck is called *restitution* or *exterior rotation*.

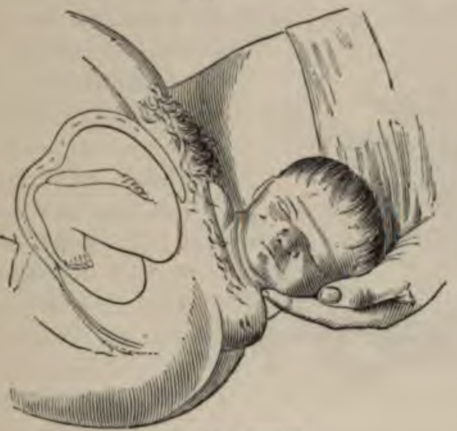
Fig. 247.



Restitution.

The head being now delivered, the shoulders descend, the bis-acromial diameter (4 inches) more or less nearly in the right oblique (5 inches), the dorso-thoracic (3 inches) in the left oblique, the long axis of the trunk more or less in the axis of the superior strait. The large head having passed, there is no resistance. The anterior shoulder sinks down along the right anterior inclined plane, the posterior along the left posterior inclined plane. Presently the shoulders reach the floor of the pelvis; now, as in the case of the occiput, they can advance no farther in the direction of the axis of the superior strait, and the movement which we have called rotation takes place. Under this movement the anterior shoulder sweeps over the right anterior inclined plane, and finally gets under the arch of the pubis. This rotation of the shoulders now places the head *transverse* at the outlet. The anterior shoulder becomes locked behind and under the arch, while the posterior shoulder distends the soft parts and describes round the anterior shoulder, resting on the subpubic ligament as a point of support, the arc of a circle from the coccyx to the fourchette, the radius being the bis-acromial diameter.

FIG. 248.



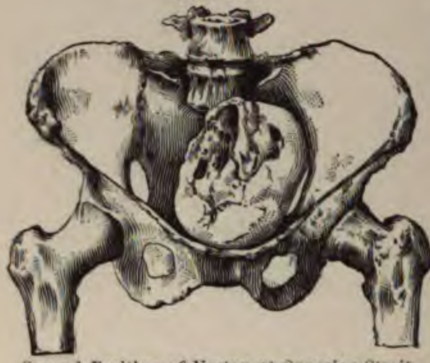
External Rotation.

Although the pubal shoulder appears first beneath the arch, circumstances determine which shall be born first. Thus, if the perineum be relaxed, as in women who have borne children, or where laceration has occurred in former labors, the sacral shoulder escapes first; but if the perineum be rigid, as in first labors, the sacral shoulder is retained until after the pubal shoulder is born. When the shoulder is under the arch the child's body is strongly flexed. Generally, after the birth of the shoulders, the stretched parts offer no resistance to the rest of the body, which is expelled, practically, without a mechanism. But we may suppose a theoretical case where the hips of the child are very large and fat, and where there is, consequently, some detention. In a theoretical case of this kind there *might* (?) be a twist in the loins of the child, and there *might* (?) be, in consequence, after the expulsion of the shoulders, an untwisting of the loins, the shoulders assuming an oblique position at the vulva (*restitution* of the shoulders). The hips then would descend precisely as the shoulders had done; they *might* (?) even rotate, so as to bring the anterior hip beneath the arch, and in this relation be expelled.

Mechanism of the Second Position.—*The Second Position of the Vertex, the Right Occipito-anterior Position.*—In this position the occiput looks to any part of the right anterior inclined plane. In the second position we have precisely the same diameters involved as in the first position, with an identical mechanism.

The presence of the rectum on the left side, if distended, might interfere with the easy rotation of the face into the hollow of the sacrum. In the second position the occiput rotates to the pubis on the right anterior inclined plane, just as it rotated, in the first position, on the left anterior inclined plane. The delivery of the body in the second position, is also exactly similar to the delivery of the body in the first position.

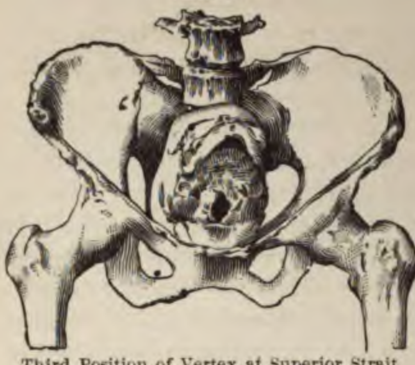
Fig. 249.



Second Position of Vertex at Superior Strait.

Mechanism of the Third Position.—*Third Position, Sacro-pubic.*—In this position the occiput looks directly in front. The third position is rare: some authorities deny it entirely. Our remarks on the causes of presentation and position explain its possibility, however. Even when existing at the beginning of labor, the occiput playing on the projecting interpubic pad, and the forehead on the round promontory of the sacrum, almost necessarily cause the third position to become spontaneously converted into a first or a second position. Should this spontaneous conversion not occur, there would be the following mechanism.

Fig. 250.

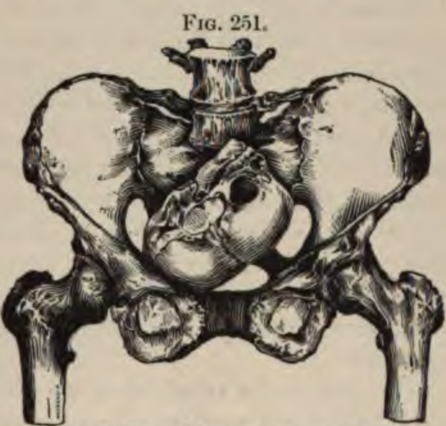


Third Position of Vertex at Superior Strait

The great difficulty would be at the superior strait. What is essential is that the cervico-bregmatic circumference should fairly offer at the superior strait. If the head is not perfectly flexed, there will offer the occipito-frontal circumference. The occipito-frontal diameter is 4 inches; the antero-posterior diameter of the superior strait is 4 inches: 4 inches cannot pass through 4 inches, consequently the head will be arrested at the superior strait. When, however, the head is *perfectly* flexed at the superior strait, the cervico-bregmatic diameter, 3½ inches, offers to the antero-posterior diameter of the strait, 4 inches. There is no difficulty, and the head readily engages and descends, the occiput sinking directly behind the symphysis pubis, and finally getting beneath the arch. Extension then follows, as in the first and second positions. As there has been no rotation of the occiput, there is no twist in the neck of the child, and hence when the head is born there is no restitution. The shoulders now engage transversely, the bis-acromial diameter (4 inches) offering to the transverse of the superior strait (5¼ inches). They descend and reach the floor of the pelvis: rotation may or may not take place; if it should take place, accident determines which shoulder shall rotate in front; after this movement the body is expelled as in other cases.

OCCIPITO-POSTERIOR POSITIONS.—*Fourth Position, Right Occipito-posterior Position.*—The fourth position is the reverse of the first position, the occiput looking to any part of the right posterior inclined plane. In this position the anterior plane of the child looks in front and to the left; the back of the child, behind and to the right. One hip, shoulder, and parietal protuberance look in front and to the right side; the opposing hip, etc. look behind and to the left.

FIG. 251.



Fourth Position of Vertex at Superior Strait.

The relations, at the superior strait, of the head to the brim, in a fourth position, are identical with those we studied as characterizing the first position, save that the occipital extremity of the cervico-bregmatic diameter looks behind and to the right, instead of in front and to the left, as in a first position. We have also the same partial flexion before the rupture of the bag of waters, and, after the escape of the liquor amnii, the flexion of the head completed, as in a first position.

As we have 3½ inches corresponding to 5 and 5¼ inches, there is no difficulty at the superior strait. The head descends as in a first position, and reaches the floor of the pelvis. Here, as in a first position, it is arrested, being unable to advance any farther in the direction of the axis of the superior strait, and labor may terminate in one of three ways.

In the vast majority of cases, the mechanism scarcely differs from that described for the first and second positions; that is, the head, having reached the floor of the pelvis, undergoes a movement of rotation, in consequence of which the occiput traverses the whole right lateral half of the cavity from behind forward, and ultimately gets beneath the arch of the pubis. In other words, a fourth position of the vertex—a right occipito-posterior position—in the vast majority of instances, terminates as if it had been a primitive second position or a right occipito-anterior position. In some cases this anterior rotation of the occiput does not take place. These cases, however, are exceedingly rare. Naegele only met 17 exceptions, in 1244 cases of occipito-posterior positions, where the occiput failed to rotate to the pubic arch. In all of these exceptional instances it was not difficult to recognize the unusual circumstances which caused the failure in anterior rotation. These unusual circumstances were "an amplitude of the pelvis, or numerous former labors; lacerations of the perineum, or the softness, flexibility, reductibility, and want of consistency of the head, or an extreme smallness of the child; the presence of twins, etc. etc."

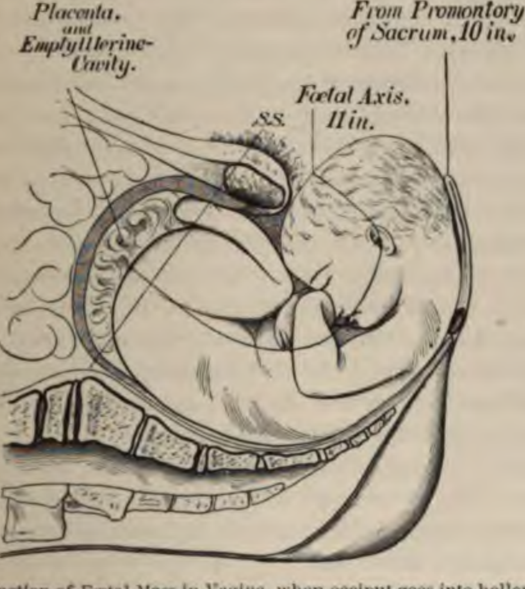
In cases where the occiput, from any cause, does not rotate in front, it rotates back into the hollow of the sacrum, and the top of the forehead gets *behind* the symphysis pubis. This posterior rotation of the occiput, even in the most favorable cases, is always undesirable: the easiest case is always more difficult, painful, and dangerous, both to mother and child, than if anterior rotation had occurred. But, in some instances, the rotation of the occiput into the hollow of the sacrum furnishes some of the grave cases in obstetrical surgery, compromising the lives of mother and child, and demanding the clearest judgment, a thorough appreciation of the mechanism of labor involved, and a willingness to accept responsibility, unfortunately, not always or often met with.

If I were to be asked what one obstetrical difficulty, in my experience, had caused most maternal and fœtal deaths, what one had caused most maternal and fœtal accidents not necessarily fatal—accidents, however, often making the rest of life worthless, or, still worse than merely worthless, a tragedy—I think I would say, "Occipito-posterior positions where the occiput had rotated into the hollow of the sacrum, and which had been *improperly treated.*"

Authorities differ as to the mechanism of these cases, and I must refer the reader to the ordinary textbooks for the several opinions held. I shall give only my own views as to the cause of the difficulty.

A glance at the pelvic cavity will show that in *occipito-anterior* positions the occiput has but, comparatively, a very short distance to traverse from the superior to the inferior strait before it escapes from the pelvic cavity. Thus, directly in front, the depth of the pelvic cavity is only one and a half inches, and even the greatest depth at the sides is only three and a half inches. How great is the difference between either of these distances and that which the occiput is compelled to pass over when it has rotated into the hollow of the sacrum! The depth of the bony pelvis from the promontory of the sacrum to the point of the receded coccyx is five inches, and if we add five inches more to these five inches, as the measure of the distended perineum, we find that the distance which the occiput has to travel from the promontory of the sacrum to the anterior edge of the distended perineum is ten inches, more or less. The length of the back of the child's neck is one and a half inches; and this is quite sufficient in occipito-anterior positions, after rotation has taken place, to reach from the superior to the inferior strait; so that in occipito-anterior positions the body of the child remains in the cavity of the uterus, distending it, and the shoulders are at the superior strait, until the head is almost or quite expelled. In other words, in occipito-anterior positions, in consequence of these conditions, the cavity of the uterus is distended, and the walls of the

FIG. 252.


Placenta. and Empty Uterine-Cavity.
From Promontory of Sacrum, 10 in.
Fœtal Axis. 11 in.
S.S.

Showing Impaction of Fœtal Mass in Vagina, when occiput goes into hollow of sacrum.

organ are capable of exerting their maximum expelling force until the head—the great difficulty of labor—is born. After the head has escaped from the vulva, the shoulders descend into the pelvis, and the cavity of the uterus becomes more and more empty, its expelling powers, consequently, correspondingly more and more feeble; but here the loss of power is of no consequence, since the large and hard head in its passage, under the influence of the maximum forces of labor, has so stretched the perineum and all the external soft parts that they offer little or no resistance to the subsequent escape of the rest of the body.

Should, however, the occiput rotate into the hollow of the sacrum instead of to the pubis, all of these favoring circumstances are lost. The distance the occiput has to traverse from the promontory of the sacrum to the edge of the distended soft parts is, as we have just seen, ten inches; but the length of the back of the child's neck is one and a half inches—less than one-sixth of the whole distance to be passed. Hence, before the occiput can reach the anterior edge of the perineum and be born, the shoulders and whole body of the child must be jammed down into the cavity of the pelvis, until, finally, the pelvis becomes impacted with the fœtal mass. But the whole length of the uncompressed fœtal ellipse is only eleven inches; hence, before the occiput can escape, the whole eleven inches of fœtal ellipse must be packed into the cavity of the pelvis. This necessarily implies that the cavity of the uterus in these cases becomes practically empty, and therefore the uterine expelling power is practically lost—practically lost long before the delivery of the head is possible; lost, too, under conditions where the maximum expelling powers would be most desirable if they could be brought to bear. We have, then, in these cases, the obstruction and difficulty increasing, while the powers diminish, until, long before the head is delivered, the uterine powers have been lost completely, and the impacted pelvis can be *naturally* emptied of the obstructing mass *only* by the bearing-down, voluntary efforts of the unfortunate mother. Is it to be wondered at, that, with such a combination of adverse conditions, posterior rotation of the occiput should, at times, furnish some of the gravest and saddest cases in obstetrics?

This explanation enables us to understand how, sometimes, in these cases, delivery with the forceps is simply impossible, and why, when this instrument is injudiciously used, it becomes such a potent cause of death both to mother and child.

In contemplating the mechanism of labor in these cases, it is evident that Nature frequently cannot accomplish the delivery. Should, however, the case terminate spontaneously, the mechanism would be as follows: The head would become greatly flexed, almost or quite at right angles to the spine (and this extreme flexion implies great loss of expelling force, which is wasted on the anterior face of the sacrum).

The whole fœtal ellipse becomes jammed down into the cavity of the pelvis. The uterine power is gradually lost. The perineum becomes greatly distended, and laceration is most common. Finally, the head is expelled by the *voluntary bearing-down* efforts of the mother. The occiput glides over the edge of the distended perineum, and the forehead and face appear under the arch of the pubis. The head becomes more and more flexed until the cervico-frontal circumference escapes. At this instant the perineum slips up along the back of the child's neck, and the head is rapidly delivered by a process of *extension* backward, the nape of the neck resting on the edge of the perineum, and the forehead and face appearing under the arch of the pubis. An arc of a circle is described, as the head extends back, with the nape of the neck resting on the edge of the perineum as a pivot, the radius being the cervico-frontal diameter. As soon as the head is delivered, the shoulders and body follow, very much as already studied in occipito-anterior positions. But it must be recollected that the shoulders have been jammed in the pelvic cavity for a long time, and that, hence, restitution of the escaped head and subsequent rotation of the shoulder are less likely to happen.

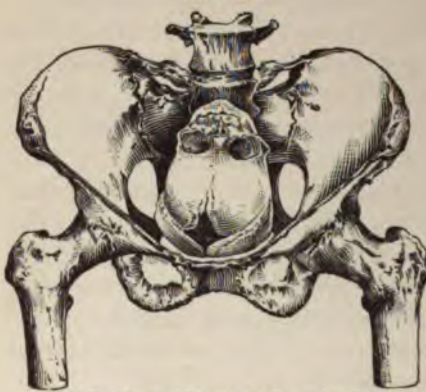
We have stated that labor, in the fourth position, after the head has reached the floor of the pelvis, might terminate in one of three ways. The third way is very rare. In these cases the occiput reaches the floor of the pelvis and becomes caught or fastened on some abnormal projecting surface or point, in such a manner that anterior or posterior rotation becomes impossible. The chin now leaves the breast of the child and sinks behind the pubis, and ultimately the case terminates as a face presentation of a mento-anterior variety. In a case of this sort, we may suppose the occiput arrested, and its further advance rendered impossible by some cause or other: a long and hooked spinous process of the ischium could furnish such an obstruction. It should now be called to mind what takes place in every case of labor, in an occipito-anterior position, when the occiput gets locked beneath the arch of the pubis. The opposite extremity of the head, the chin, as the only part free to move, under the force of the expelling powers, leaves the breast of the child, and the head extends; and this is precisely what we have taking place in these very rare cases. The occiput becomes arrested; it can advance no farther; it can rotate neither forward nor backward; and, finally, the chin, as the only part of the head free to move, leaves the breast of the child, and the head extends, and the labor terminates as a face presentation. The occipito-mental diameter of the head is 5 inches, the oblique diameter of the cavity is 6 inches; hence this extension of the head is entirely possible.

FIFTH POSITION.—*Left Occipito-posterior Position.*—The fifth position is the reverse of the second position, and bears the same relation to it that the fourth bears to the first. The position of the rectum, if not empty, might interfere; if empty, the case is identical in its mechanism with that of the fourth position, which we have just studied. The fifth position, for reasons already studied, must be exceedingly uncommon.

SIXTH POSITION.—*Occipito-sacral.*—The sixth position is the reverse of the third. The relationship of diameters with the diameters of the brim is precisely the same as that which we have already studied in the third position. The existence of the sixth position is denied by most authorities. There is no doubt, however, that it sometimes happens, and, as we shall see, is by far the most undesirable of the occipito-posterior positions. In a sixth position the occiput looks directly to the promontory of the sacrum. Early in labor the smooth back of the head, playing on the smooth and round promontory of the sacrum, causes the head to assume an oblique position at the superior strait; in other words, causes an *apparent* fourth or fifth position. The medical attendant, conducting his examinations, diagnoses a fourth or fifth position, and does not realize that the position is apparent and not real, and that the back of the child is still looking directly to the back of the mother, and that there is a twist in the neck. As soon as the head has passed the brim—much sooner than in a primitive fourth or fifth position, in which rotation occurs ordinarily only when the head reaches the pelvic floor—the neck untwists and the occiput is thrown into the hollow of the sacrum. In other words, the occiput, in a sixth position, *never rotates to the front, but always goes into the hollow of the sacrum.* Hence a sixth position is the most difficult of all the occipito-posterior positions.

Should the head, in a sixth position, fail to assume the oblique position at the superior strait that, we have just seen, it must almost necessarily do, but remain with the occiput looking directly to the promontory of the sacrum, then the identical conditions and difficulties would exist which we have already studied in a third position, when the head did not spontaneously assume an oblique position at the superior strait; that is, the cervico-bregmatic diameter ($3\frac{1}{2}$ inches) would be in relation with the antero-posterior diameter of the superior strait (4 inches). Hence, if perfect flexion existed the head would pass and sink into the hollow of the sacrum, and labor would

FIG. 253.



Sixth Position of Vertex at Superior Strait.

terminate as we have just described. Should, however, the head be only partially flexed, the occipito-frontal diameter (4 inches) would offer and the head would be arrested.

In describing the mechanism of labor, and the various movements and changes occurring during the process, it has been necessary, in order to give an accurate idea of these several movements, to speak of them as taking place successively. Thus we have stated that first we have adaptation (flexion in vertex presentation); then descent; then rotation, etc. etc. Now, really, these movements do not always occur in the exact order described. Thus it often happens that the head does not flex perfectly before it descends into the cavity of the pelvis, complete flexion failing to take place until the head encounters the resistance at the floor of the pelvis, and then only, in the great majority of cases, is flexion carried to its highest degree. This we can readily understand when we bear in mind that the diameters of the superior strait, when the head offers in any of the four oblique positions, are so large (5 and 5¼ inches) that there is no resistance whatever (the cause of flexion) until the head reaches the floor.

Again, we say, "First, flexion; then descent; then rotation, etc. etc." Actually, however, in many cases rotation begins before descent is completed, the first three changes of flexion, descent, and rotation being coincident movements. Again, in some instances, the occiput does not rotate completely, and the head is born by a process of extension, the nape of the neck resting, not beneath the symphysis pubis, but against the ischio-pubic ramus. Finally, in some cases the head does not rotate at all, but is delivered by a process of extension, the nape of the neck resting on one tuberosity of the ischium, and the face appearing, as the head extends, at the opposite one. This movement of rotation certainly is a very interesting one. We have seen in all positions, save the sixth, the almost universal result is anterior rotation of the occiput. The question naturally suggests itself, "What is the cause of rotation?" The usual explanation is that rotation is caused by the inclined planes of the pelvis—that if, in a vertex presentation, the occiput strike on an *anterior* inclined plane, it *must* rotate to the symphysis pubis; if it strike on a posterior inclined plane, it *must* rotate into the hollow of the sacrum. Dubois, denying the influence of the inclined planes, maintains that "the cause evidently resides in a combination of a great number of elements—viz. on the one hand the size, form, and mobility of the parts which are expelled, and, on the other, the capacity, the shape, and the resistance of the canal traversed by them;" which, he says, "render all this very simple and intelligible." The reader may decide for himself how "simple and intelligible" Dubois' theory is.

The usual explanation of rotation, that it is caused by the influence of the inclined planes of the pelvis, undoubtedly has some truth in it.

That is, it must be admitted that rotation occurs in consequence of the peculiar shape and direction of the pelvic canal, and that if the pelvic canal were of different shape and direction different results would take place. Yet the inclined-plane theory, or the theory of Dubois, is not satisfactory. Each fails to give a clear and definite idea of the precise cause of rotation as well as the precise cause of the various exceptions and anomalies to which I have referred. Thus, for example, we have seen that, in most cases, the head does not *begin* to rotate until it has reached the floor of the pelvis. But we also know that, in some instances, rotation begins the moment the head enters the superior strait and at the very beginning of labor, while, finally, in others, rotation does not take place at all, or does so only imperfectly. And yet, in all of these varied movements, the head has played on those inclined planes which, we are assured, are the cause of rotation. Why, then, if the same causes are acting in every instance, do we meet with such different results? Why does rotation take place? and why does it not take place? or why does it take place only partially? The inclined-plane theory, or the theory of Dubois, is not comprehensive enough to meet the question.

The only really entirely satisfactory explanation of the cause of this movement of rotation, with all the anomalies and exceptions to which I have referred, is that suggested by Cazeaux. Cazeaux's theory is as follows: The expelling forces of labor act, as we know, in the direction of the axis of the superior strait. The child in labor is urged in this direction. Take the fourth position of the vertex as an illustration. The head descends in the line of the axis of the superior strait; presently it reaches the obliquely-inclined surface of the right posterior part of the pelvic cavity, and is arrested. The occiput is now placed under the influence of two forces—the force of expulsion, which we may represent by a line drawn in the direction of the expelling forces; that is, from above downward, from before backward, and slightly from left to right; and the force of resistance, which force we can represent by a line drawn perpendicularly to the obliquely-inclined surface on which the occiput strikes, and which arrests its further progress in the line of the axis of the superior strait. This force of resistance, then, is a force acting in the direction of a line drawn from behind forward and from below upward.

The child's occiput is, then, from the moment of contact with the floor of the pelvis, placed under the action of two forces, the one urging it down, back, and to the right; the other urging it forward and upward.

If the reader will now turn to any work on Physics, he will find this proposition:

*When a body free to move is acted upon by two forces, it moves in the* *direction of neither of these forces, but in the direction of their resultant; which resultant is the diagonal of a parallelogram of which these two forces form two sides.*

When two sides and the included angle of a parallelogram are given, all that is necessary to complete the figure is to draw lines parallel to the given sides, and the direction of the resultant diagonal is at once revealed.

Hence the occiput, acted on by the two forces, moves in the direction of neither, but in the direction of their resultant diagonal; that is, it moves, in this particular position employed as our illustration, forward, downward, and to the right; which movement presently brings it to the arch of the pubis. This theory of Cazeaux enables us to understand how the extent of this progress of the occiput and the rapidity of its execution are always proportionate to the energy and duration of the expelling forces and the resistance offered by the pelvic floor. It also explains why rotation, after being a long time delayed, is sometimes suddenly and completely effected by one violent pain; and also why, when the pains are feeble and short, the anterior rotation takes place much more slowly. This theory enables us to explain those differences noticed in rotation as to the part of the cavity where it commences. Thus we have seen that it usually begins only when the head reaches the floor of the pelvis. This we would expect, since until then the flexed head has encountered no resistance whatever. But should the head be large, or the pelvis rather small, or the superior strait be much inclined, or the uterus oblique, resistance would be offered as soon as the head engaged, and the head would be compelled to describe the diagonal or resultant movement.

We can now easily understand why, in some cases of occipito-anterior position, rotation takes place only partially, and why in some cases it does not take place at all. When only partial rotation occurs, it is because the head is small, or the pelvis capacious, or the soft parts relaxed, or all of these conditions are combined; and the result is that the force of resistance is not sufficient to impress a complete diagonal or resultant movement on the occiput, and only partial rotation is possible. Similar conditions, intensified, explain cases where there is no rotation whatever. Here there is no force of resistance at all; hence no attempt at a diagonal or resultant movement is made, and the head escapes from the inferior strait in the same position it entered the pelvis.

This theory enables to understand why, in the oblique occipito-posterior positions of the vertex, the occiput in very rare cases goes into the hollow of the sacrum instead of rotating beneath the arch of the pubis. Naegele states that out of 1244 cases of occipito-posterior positions, in all save 17 the occiput finally rotated to the front; and in these 17 rare cases it was easy to appreciate the exceptional causes that occasioned the unusual result. These causes were the small size of the fœtus or of its head, or the great size of the pelvis, or conditions which caused the soft parts to offer no resistance; in other words, in all of these 17 exceptional cases the unusual conditions were such as took away all force of resistance; hence there was no diagonal movement impressed on the occiput when it reached the floor of the pelvis, and the propelling forces, acting in the line of the axis of the superior strait, pushed it into the hollow of the sacrum.

## DIAGNOSIS OF VERTEX PRESENTATIONS.

Before labor, and even during the last few months of gestation, the vertex can often be recognized as presenting; while in every other presentation, the part that offers first, save in breech presentations, when the lower extremities are extended and in close contact with the anterior plane of the child, from being irregular, voluminous, and badly adapted to the form of the inferior uterine segment and of the superior strait, is always so high up, and separated from the uterine wall by so large a quantity of waters, as to be scarcely accessible to the finger.

The vertex, on the contrary, presenting a rounded spheroidal surface, reposes, almost without the intervention of any liquid, on the uterine walls, and even presses them before it and engages in the excavation, descending in some cases as low down as the floor of the pelvis. Hence, whenever the vertex presents it is easily detected through the inferior portion of the uterine wall, unless, indeed, it should be retained at the superior strait by a considerable inclination of the womb, or by some unusual condition, as in twins, or by some abnormal condition either in the fœtus or uterus or pelvis.

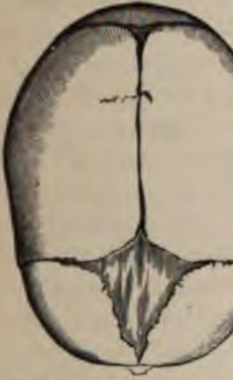
It should, therefore, always be remembered that whenever the medical attendant does not easily reach the presenting part in the last few days of gestation, and more particularly during the first periods of labor, he should examine the woman very carefully; for it is then exceedingly probable that the head is not at the superior strait; or even where the cephalic extremity does present flexed there is reason to fear a wrong direction, or perhaps a vicious organization, of the head or pelvis; all of which circumstances may subsequently require the intervention of his art.

The form of the uterus is, then, such as we have described as normal, some modifications, however, being observable in occipito-posterior positions. Thus, the womb is still widest at its upper part, but its fundus is not so regularly rounded, unless it should contain a large quantity of fluid; generally the fundus has an arched appearance, whilst beneath it is a sensible depression. The anterior plane of the fœtus being directed forward, the inequalities produced by its extremities are perceptible, which is not the case so distinctly in the occipito-anterior positions.

Auscultation is a resource of great value in establishing the diagnosis. In vertex presentations the pulsations of the fœtal heart are heard in one of the iliac fossæ—the left when the occiput is turned to the left, and the right in the opposite case. Again, let it be borne in mind that the active fœtal movements felt by the mother at the same part of the abdomen for a long time indicate the correspondence of this point with the anterior region of the child.

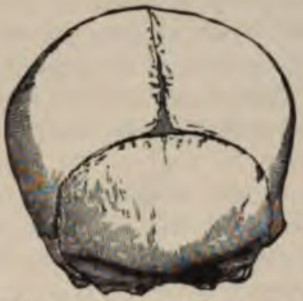
Supposing the labor has begun, if the finger be introduced through the cervix uteri, it will immediately encounter a rounded, smooth, and resistant surface, which is the anterior side of the head; and then, by directing the index a little farther upward and backward, in the direction of the sacro-vertebral angle, it will come into contact with a membranous interval; that is, with the sagittal suture.

FIG. 254.



Anterior and Posterior Fontanels.

FIG. 255.



Biparietal Diameter, Sagittal and Lambdoidal Sutures, with Posterior Fontanel.

A vertex presentation is now ascertained, and the next step is to make out the position. For that purpose we first assure ourselves of the direction of the suture, and if it prove to be oblique, running from before backward and from the left toward the right, the position must either be the left occipito-anterior or the right occipito-posterior one; but, on the contrary, if it be oblique in the other diameter, the position will either be the right occipito-anterior or the left occipito-posterior.

The direction being once determined, we have then only to find out where the occiput lies to complete the diagnosis; therefore, the finger by raising up the margin of the os uteri follows the sagittal suture until it reaches a fontanel.

## THE TREATMENT OF VERTEX PRESENTATIONS, BASED ON THE MECHANISM.

It is evident from our study of the mechanism of labor in vertex presentations, that the mechanism of the first position is the easiest and simplest form of mechanism possible, as, fortunately, it is the most common. The treatment, therefore, of labor when the child offers in the first position of the vertex is the treatment demanded in ordinary natural labor, and requires no further comment.

SECOND POSITION.—*Right Occipito-anterior Position.*—In the second position rectal accumulations might interfere with the descent and rotation of the head. A suitable enema would remove these, when the case would need only the treatment of natural labor.

THIRD POSITION.—*Occipito-pubic.*—We have seen that a third position usually becomes spontaneously converted into a first or second at the beginning of labor. The indications then are to favor this spontaneous conversion at the superior strait. This may generally be done by the finger acting on the forehead, so as to force the head into an oblique position. In a more difficult case the whole hand might be introduced, the head be grasped, and *during the absence of pains* gently pushed slightly up and loosened and placed in an oblique position, or the forceps could be applied and the same kind of manœuvre practised. Finally, in any instance where the head cannot be made to assume an oblique position at the superior strait (though a case of the kind must be considered almost a theoretical one), it will be necessary to secure perfect flexion of the head by the aid of the finger, hand, lever, or forceps. As soon as the cervico-bregmatic diameter (3½ inches) is made to offer to the 4 inches of the antero-posterior diameter of the superior strait, the head will pass without difficulty. In an occipito-pubic position, should the shoulders come down transverse, labor will be rendered easier by favoring rotation by pushing one shoulder into the hollow of the sacrum.

FOURTH POSITION.—*Right Occipito-posterior Position.*—Fortunately, as we have seen, the oblique occipito-posterior positions in almost every instance terminate by anterior rotation of the occiput. Nevertheless, even when this most desirable movement takes place spontaneously, the struggle between the forces of propulsion and resistance is always greater than in primitive occipito-anterior positions—usually, immensely greater. Consequently, labor is longer, more painful, and more dangerous to both mother and child. Hence most authorities advise that anterior rotation should be assisted, and thus the struggle be made shorter and less painful. Should such assistance be decided upon, it must be recollected that it is not to be attempted, in ordinary cases, until the head has reached the floor of the pelvis; in other words, until the head has reached that part of the pelvic cavity where rotation takes place naturally and spontaneously. Sometimes rotation can be secured by the finger alone placed on the side of the forehead. Usually, however, bipolar pressure is necessary; that is, one or two fingers can be placed on the side of the forehead and a lever be inserted over the side of the occiput. Often the best method is to apply the *straight short* forceps, secure rotation, and then complete the delivery by aid of this instrument.

None of these manipulations are to be done rudely or quickly; on the contrary, they should be kept up for a long time. Gentleness, not violent force, is essential to the safe and proper management of these often most difficult and trying cases. The head is rather to be *coaxed*, than compelled, to rotate.

Spontaneous rotation takes place much more easily and quickly in these cases when the bag of waters is not ruptured. Hence, should an occipito-posterior position be recognized during the first stage of labor, care must be taken to preserve the bag as long as possible—certainly until the occiput has come to the front.

It is asserted that the position of the woman on her right or left side (according as the case may be a right or left occipito-posterior position) favors signally spontaneous rotation. Hence the simplest and often best treatment is to preserve the bag of waters, and place the woman on her right or left side, and attempt nothing else until these have proved ineffectual. Constantly, however, the forceps will be found necessary, if not to secure rotation, at least to relieve a woman exhausted by prolonged effort, and a child in great peril from prolonged pressure.

The occiput, in spite of any or all of the assistance just recommended, sometimes goes into the hollow of the sacrum. I believe that in the great majority of such cases, when such posterior rotation takes place, *notwithstanding* all our efforts to prevent it, the case is really a sixth position—an occipito-sacral position; that the head early in the labor assumed an oblique position at the superior strait; that the body, however, did not participate in this movement, but was held tightly by the grasp of the uterine walls, with the back of the child's body looking directly to the spinal column of the mother; that the medical attendant diagnosed (he could not do otherwise) an *oblique* occipito-posterior position of the vertex: he has attempted to secure rotation, and has failed, not because his manipulations were not skilfully rendered, perhaps, but solely for the reason that the walls of the uterus grasped the body of the child so tightly that the head could not even be forced to rotate. I believe that in all cases, where a normal head fails to rotate on a normal perineum, the trouble is a sixth position. The occiput then sometimes, in spite of every effort to prevent it, goes into the hollow of the sacrum, and the result is, if the head be large or the soft parts rigid, often one of the most difficult cases in obstetrical surgery. In these cases of posterior rotation, unless the child be small, the pelvis capacious, the soft parts relaxed, and the *voluntary powers* great, we need not expect the labor to terminate, spontaneously, safely to mother and child. An impacted head for only three or four hours may prove quite sufficient to cause sloughing of the maternal parturient surfaces, with all the subsequent horrors that such sloughing suggests, from puerperal septicæmia down. At the same time, the cerebral centres of the child may undergo dangerous or fatal compression.

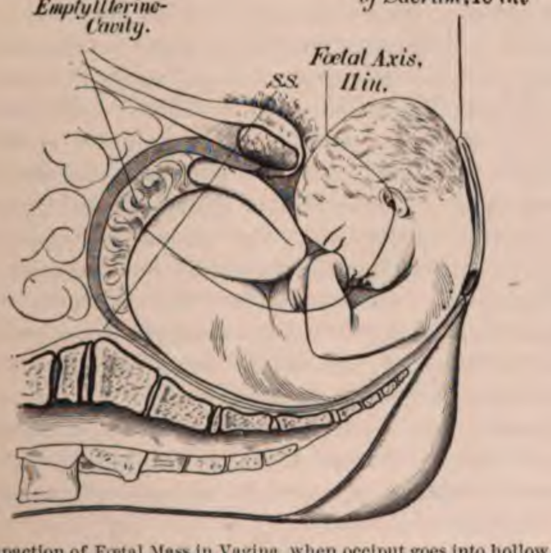
My earnest advice, in all difficult cases of this kind, is not to hesitate or vacillate or delay, but promptly to furnish assistance. A pair of *short*, *straight* forceps should be applied *immediately*, and a firm but prudent attempt be made to *force* (the time for coaxing has passed) a rotation of the occiput to the pubis. In doing this we transgress the rule not to force the child's head to rotate more than a quarter of a circle, for fear of dislocating its cervical vertebræ. But we are justified in this heroic procedure by the fact that the child's chances are greater, delivered even by this highly dangerous method, than if the case were not interfered with, while the mother is saved a most perilous labor. Should this attempt at *forced* rotation fail—and probably it will fail—then the delivery may be secured possibly by traction with the forceps, though the occiput remain in the sacrum. The forceps here must be used with the greatest care and prudence, and even when most skilfully employed may be insufficient to accomplish delivery; or, if delivery be secured by it, the pressure necessary is often so great that the child is stillborn, or its cerebral centres so damaged that it speedily perishes, or, what is worse, survives as a paralytic idiot, or, still worse, attains maturity with a mental and physical organization more or less imperfect, the result directly of the difficulties attending its birth.

Should a *prudent* application of the forceps fail—and it constantly will fail—then the forceps must be abandoned. The forceps in any difficult case of labor must only be used as a conservative instrument. When violence or improper force is resorted to, the forceps ceases to be a conservative instrument, and becomes a highly dangerous one—often as fatal to the child as a pair (which it actually becomes) of crushing craniotomy forceps, and much more dangerous than these to the mother. When we abandon the forceps, however, we do not abandon for one moment our patient. We do not think of "waiting and trusting to Nature;" there can be no rest until labor is completed. The child is practically lost, and every minute of delay lessens the chances of the mother. The next procedure is embryotomy; and this is not to be slowly thought of, and still more slowly performed; but if it must be done, it must be done immediately.

held. I shall give only my own views as to the cause of the difficulty.

A glance at the pelvic cavity will show that in *occipito-anterior* positions the occiput has but, comparatively, a very short distance to traverse from the superior to the inferior strait before it escapes from the pelvic cavity. Thus, directly in front, the depth of the pelvic cavity is only one and a half inches, and even the greatest depth at the sides is only three and a half inches. How great is the difference between either of these distances and that which the occiput is compelled to pass over when it has rotated into the hollow of the sacrum! The depth of the bony pelvis from the promontory of the sacrum to the point of the receded coccyx is five inches, and if we add five inches more to these five inches, as the measure of the distended perineum, we find that the distance which the occiput has to travel from the promontory of the sacrum to the anterior edge of the distended perineum is ten inches, more or less. The length of the back of the child's neck is one and a half inches; and this is quite sufficient in occipito-anterior positions, after rotation has taken place, to reach from the superior to the inferior strait; so that in occipito-anterior positions the body of the child remains in the cavity of the uterus, distending it, and the shoulders are at the superior strait, until the head is almost or quite expelled. In other words, in occipito-anterior positions, in consequence of these conditions, the cavity of the uterus is distended, and the walls of the

FIG. 252.


Placenta, and Empty Uterine-Cavity.
From Promontory of Sacrum, 10 in.
Fœtal Axis, 11 in.
S.S.

Showing Impaction of Fœtal Mass in Vagina, when occiput goes into hollow of sacrum.

### DEVIATED OR IRREGULAR PRESENTATIONS OF THE VERTEX.

Perfect flexion of the head gives a vertex presentation. Sometimes, however, the head is not perfectly flexed, and then, instead of the cervico-bregmatic circumference, the occipito-frontal, with its 4-inch diameter, becomes involved. We have seen that the occipito-frontal circumference is common in vertex presentations before labor actually begins, since the head reposes at the mouth of the uterus, not perfectly flexed; and we have also seen that one of the earliest changes of labor is to complete the flexion of the head, and bring the vertex fairly to offer. In some rare cases, for reasons not always evident, this desirable flexion fails to take place, and we have what some authors describe as a distinct presentation.

PRESENTATION OF THE ANTERIOR FONTANEL.—Instead, however, of describing a distinct presentation of the anterior fontanel, I think the subject is simplified, and much more readily understood and recollected, by discussing it as a deviation from a vertex presentation. In any of the six positions of vertex presentations complete flexion may not take place, and a so-called presentation of the anterior fontanel is the result. Should the position be a third or a sixth, there would be an arrest of the head at the superior strait, since four inches (the occipito-frontal diameter) cannot pass through four inches, the antero-posterior diameter of the superior strait.

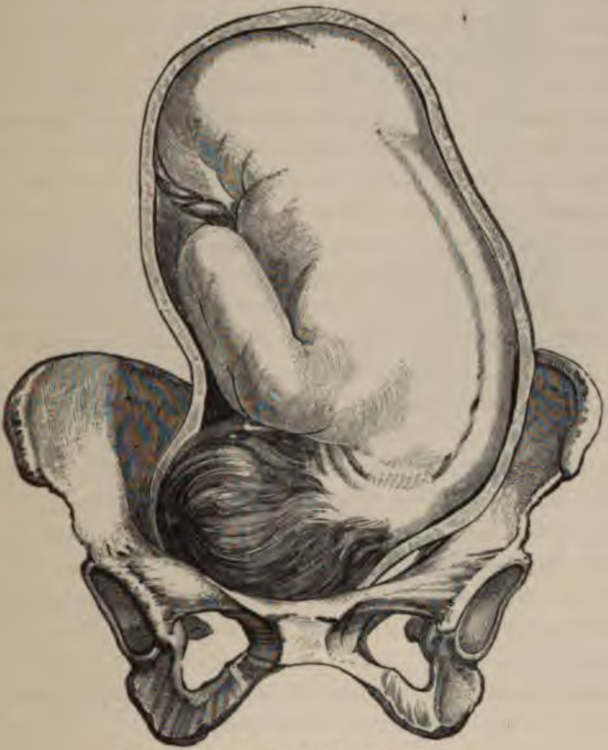
In the oblique positions of anterior fontanel presentations, the occipito-frontal diameter could pass readily through either the oblique (5 inches) or the transverse (5¼ inches) of the superior strait, but would be arrested at the inferior strait by its four-inch diameter.

The indication for treatment, in all cases of the kind now under discussion, evidently is to secure flexion; in other words, to convert a deviated vertex presentation into a complete vertex, and to cause the cervico-bregmatic circumference, with its three and a half inches of diameter, to offer instead of the occipito-frontal circumference, with its longer four inches of diameter.

Flexion is to be secured by the finger or lever, or both. A finger may be placed on the forehead, and may be kept there, and thus, often, gradually, complete flexion may be secured; or, a lever may be slipped over the occiput, and the back of the head be well brought down; or both of these manœuvres may be employed simultaneously. In occipito-posterior positions of anterior fontanel presentations the indications are to secure anterior rotation of the occiput, and, at the same time, cause the head to flex. When the forceps is demanded, it is highly important that the head should, if possible, be completely flexed before tractions are made.

INCLINED PRESENTATIONS OF THE VERTEX.—*Presentations of the Sides of the Head.*—Sometimes, in rare instances, the child offers by the side of its head. An ear or one parietal protuberance is found at the centre of the superior strait instead of the vertex. Such cases have been described as distinct presentations; but, for reasons already given in discussing presentations of the anterior fontanel, I think it more advantageous to describe them as deviations from a vertex presentation. Presentations of the side of the head undoubtedly are caused by obliquities of the uterus. Either side of the head may offer. If the presentation should persist, the difficulty is that the occipito-mental circumference, with its five-inch diameter, offers at the superior strait, and the head is arrested. Luckily, the occiput may slip into the cavity of the pelvis, the head flex, and a fair vertex presentation terminate the labor. Should this favorable spontaneous termination not happen, the head remains arrested and labor becomes impossible.

FIG. 256.

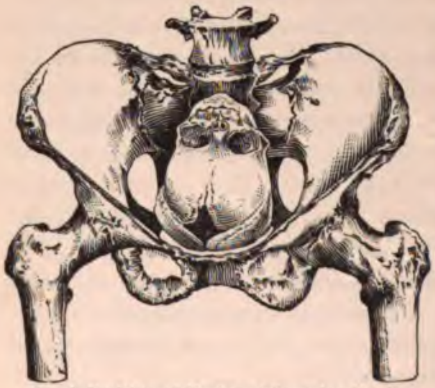


Presentation of the Left Ear (Ramsbotham).

The indication for treatment of labor in a presentation of the side of the head *is not* to "trust to Nature" or to wait for a spontaneous termination. Assistance should be *immediately* given, since all assistance is more easily rendered early in labor, but becomes more difficult to it that the fourth bears to the first. The position of the rectum, if not empty, might interfere; if empty, the case is identical in its mechanism with that of the fourth position, which we have just studied. The fifth position, for reasons already studied, must be exceedingly uncommon.

SIXTH POSITION.—*Occipito-sacral.*—The sixth position is the reverse of the third. The relationship of diameters with the diameters of the brim is precisely the same as that which we have already studied in the third position. The existence of the sixth position is denied by most authorities. There is no doubt, however, that it sometimes happens, and, as we shall see, is by far the most undesirable of the occipito-posterior positions. In a sixth position the occiput looks directly to the promontory of the sacrum. Early in labor the smooth back of the head, playing on the smooth and round promontory of the sacrum, causes the head to assume an oblique position at the superior strait; in other words, causes an *apparent* fourth or fifth position. The medical attendant, conducting his examinations, diagnoses a fourth or fifth position, and does not realize that the position is apparent and not real, and that the back of the child is still looking directly to the back of the mother, and that there is a twist in the neck. As soon as the head has passed the brim—much sooner than in a primitive fourth or fifth position, in which rotation occurs ordinarily only when the head reaches the pelvic floor—the neck untwists and the occiput is thrown into the hollow of the sacrum. In other words, the occiput, in a sixth position, *never rotates to the front, but always goes into the hollow of the sacrum.* Hence a sixth position is the most difficult of all the occipito-posterior positions.

FIG. 253.



Sixth Position of Vertex at Superior Strait.

Should the head, in a sixth position, fail to assume the oblique position at the superior strait that, we have just seen, it must almost necessarily do, but remain with the occiput looking directly to the promontory of the sacrum, then the identical conditions and difficulties would exist which we have already studied in a third position, when the head did not spontaneously assume an oblique position at the superior strait; that is, the cervico-bregmatic diameter (3½ inches) would be in relation with the antero-posterior diameter of the superior strait (4 inches). Hence, if perfect flexion existed the head would pass and sink into the hollow of the sacrum, and labor would terminate as we have just described. Should, however, the head be only partially flexed, the occipito-frontal diameter (4 inches) would offer and the head would be arrested.

In describing the mechanism of labor, and the various movements and changes occurring during the process, it has been necessary, in order to give an accurate idea of these several movements, to speak of them as taking place successively. Thus we have stated that first we have adaptation (flexion in vertex presentation); then descent; then rotation, etc. etc. Now, really, these movements do not always occur in the exact order described. Thus it often happens that the head does not flex perfectly before it descends into the cavity of the pelvis, complete flexion failing to take place until the head encounters the resistance at the floor of the pelvis, and then only, in the great majority of cases, is flexion carried to its highest degree. This we can readily understand when we bear in mind that the diameters of the superior strait, when the head offers in any of the four oblique positions, are so large (5 and 5¼ inches) that there is no resistance whatever (the cause of flexion) until the head reaches the floor.

Again, we say, "First, flexion; then descent; then rotation, etc. etc." Actually, however, in many cases rotation begins before descent is completed, the first three changes of flexion, descent, and rotation being coincident movements. Again, in some instances, the occiput does not rotate completely, and the head is born by a process of extension, the nape of the neck resting, not beneath the symphysis pubis, but against the ischio-pubic ramus. Finally, in some cases the head does not rotate at all, but is delivered by a process of extension, the nape of the neck resting on one tuberosity of the ischium, and the face appearing, as the head extends, at the opposite one. This movement of rotation certainly is a very interesting one. We have seen in all positions, save the sixth, the almost universal result is anterior rotation of the occiput. The question naturally suggests itself, "What is the cause of rotation?" The usual explanation is that rotation is caused by the inclined planes of the pelvis—that if, in a vertex presentation, the occiput strike on an *anterior* inclined plane, it *must* rotate to the symphysis pubis; if it strike on a posterior inclined plane, it *must* rotate into the hollow of the sacrum. Dubois, denying the influence of the inclined planes, maintains that "the cause evidently resides in a combination of a great number of elements—viz. on the one hand the size, form, and mobility of the parts which are expelled, and, on the other, the capacity, the shape, and the resistance of the canal traversed by them;" which, he says, "render all this very simple and intelligible." The reader may decide for himself how "simple and intelligible" Dubois' theory is.

The usual explanation of rotation, that it is caused by the influence of the inclined planes of the pelvis, undoubtedly has some truth in it.

That is, it must be admitted that rotation occurs in consequence of the peculiar shape and direction of the pelvic canal, and that if the pelvic canal were of different shape and direction different results would take place. Yet the inclined-plane theory, or the theory of Dubois, is not satisfactory. Each fails to give a clear and definite idea of the precise cause of rotation as well as the precise cause of the various exceptions and anomalies to which I have referred. Thus, for example, we have seen that, in most cases, the head does not *begin* to rotate until it has reached the floor of the pelvis. But we also know that, in some instances, rotation begins the moment the head enters the superior strait and at the very beginning of labor, while, finally, in others, rotation does not take place at all, or does so only imperfectly. And yet, in all of these varied movements, the head has played on those inclined planes which, we are assured, are the cause of rotation. Why, then, if the same causes are acting in every instance, do we meet with such different results? Why does rotation take place? and why does it not take place? or why does it take place only partially? The inclined-plane theory, or the theory of Dubois, is not comprehensive enough to meet the question.

The only really entirely satisfactory explanation of the cause of this movement of rotation, with all the anomalies and exceptions to which I have referred, is that suggested by Cazeaux. Cazeaux's theory is as follows: The expelling forces of labor act, as we know, in the direction of the axis of the superior strait. The child in labor is urged in this direction. Take the fourth position of the vertex as an illustration. The head descends in the line of the axis of the superior strait; presently it reaches the obliquely-inclined surface of the right posterior part of the pelvic cavity, and is arrested. The occiput is now placed under the influence of two forces—the force of expulsion, which we may represent by a line drawn in the direction of the expelling forces; that is, from above downward, from before backward, and slightly from left to right; and the force of resistance, which force we can represent by a line drawn perpendicularly to the obliquely-inclined surface on which the occiput strikes, and which arrests its further progress in the line of the axis of the superior strait. This force of resistance, then, is a force acting in the direction of a line drawn from behind forward and from below upward.

The child's occiput is, then, from the moment of contact with the floor of the pelvis, placed under the action of two forces, the one urging it down, back, and to the right; the other urging it forward and upward.

If the reader will now turn to any work on Physics, he will find this proposition:

*When a body free to move is acted upon by two forces, it moves in the* *direction of neither of these forces, but in the direction of their resultant; which resultant is the diagonal of a parallelogram of which these two forces form two sides.*

When two sides and the included angle of a parallelogram are given, all that is necessary to complete the figure is to draw lines parallel to the given sides, and the direction of the resultant diagonal is at once revealed.

Hence the occiput, acted on by the two forces, moves in the direction of neither, but in the direction of their resultant diagonal; that is, it moves, in this particular position employed as our illustration, forward, downward, and to the right; which movement presently brings it to the arch of the pubis. This theory of Cazeaux enables us to understand how the extent of this progress of the occiput and the rapidity of its execution are always proportionate to the energy and duration of the expelling forces and the resistance offered by the pelvic floor. It also explains why rotation, after being a long time delayed, is sometimes suddenly and completely effected by one violent pain; and also why, when the pains are feeble and short, the anterior rotation takes place much more slowly. This theory enables us to explain those differences noticed in rotation as to the part of the cavity where it commences. Thus we have seen that it usually begins only when the head reaches the floor of the pelvis. This we would expect, since until then the flexed head has encountered no resistance whatever. But should the head be large, or the pelvis rather small, or the superior strait be much inclined, or the uterus oblique, resistance would be offered as soon as the head engaged, and the head would be compelled to describe the diagonal or resultant movement.

We can now easily understand why, in some cases of occipito-anterior position, rotation takes place only partially, and why in some cases it does not take place at all. When only partial rotation occurs, it is because the head is small, or the pelvis capacious, or the soft parts relaxed, or all of these conditions are combined; and the result is that the force of resistance is not sufficient to impress a complete diagonal or resultant movement on the occiput, and only partial rotation is possible. Similar conditions, intensified, explain cases where there is no rotation whatever. Here there is no force of resistance at all; hence no attempt at a diagonal or resultant movement is made, and the head escapes from the inferior strait in the same position it entered the pelvis.

This theory enables to understand why, in the oblique occipito-posterior positions of the vertex, the occiput in very rare cases goes into the hollow of the sacrum instead of rotating beneath the arch of the pubis. Naegele states that out of 1244 cases of occipito-posterior positions, in all save 17 the occiput finally rotated to the front; and in these 17 rare cases it was easy to appreciate the exceptional causes that occasioned the unusual result. These causes were the small size of the fœtus or of its head, or the great size of the pelvis, or conditions which caused the soft parts to offer no resistance; in other words, in all of these 17 exceptional cases the unusual conditions were such as took away all force of resistance; hence there was no diagonal movement impressed on the occiput when it reached the floor of the pelvis, and the propelling forces, acting in the line of the axis of the superior strait, pushed it into the hollow of the sacrum.

## DIAGNOSIS OF VERTEX PRESENTATIONS.

Before labor, and even during the last few months of gestation, the vertex can often be recognized as presenting; while in every other presentation, the part that offers first, save in breech presentations, when the lower extremities are extended and in close contact with the anterior plane of the child, from being irregular, voluminous, and badly adapted to the form of the inferior uterine segment and of the superior strait, is always so high up, and separated from the uterine wall by so large a quantity of waters, as to be scarcely accessible to the finger.

The vertex, on the contrary, presenting a rounded spheroidal surface, reposes, almost without the intervention of any liquid, on the uterine walls, and even presses them before it and engages in the excavation, descending in some cases as low down as the floor of the pelvis. Hence, whenever the vertex presents it is easily detected through the inferior portion of the uterine wall, unless, indeed, it should be retained at the superior strait by a considerable inclination of the womb, or by some unusual condition, as in twins, or by some abnormal condition either in the fœtus or uterus or pelvis.

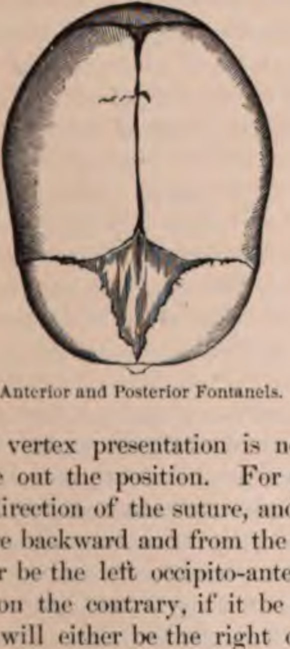
It should, therefore, always be remembered that whenever the medical attendant does not easily reach the presenting part in the last few days of gestation, and more particularly during the first periods of labor, he should examine the woman very carefully; for it is then exceedingly probable that the head is not at the superior strait; or even where the cephalic extremity does present flexed there is reason to fear a wrong direction, or perhaps a vicious organization, of the head or pelvis; all of which circumstances may subsequently require the intervention of his art.

The form of the uterus is, then, such as we have described as normal, some modifications, however, being observable in occipito-posterior positions. Thus, the womb is still widest at its upper part, but its fundus is not so regularly rounded, unless it should contain a large quantity of fluid; generally the fundus has an arched appearance, whilst beneath it is a sensible depression. The anterior plane of the fœtus being directed forward, the inequalities produced by its extremities are perceptible, which is not the case so distinctly in the occipito-anterior positions.

Auscultation is a resource of great value in establishing the diagnosis. In vertex presentations the pulsations of the fœtal heart are heard in one of the iliac fossæ—the left when the occiput is turned to the left, and the right in the opposite case. Again, let it be borne in mind that the active fœtal movements felt by the mother at the same part of the abdomen for a long time indicate the correspondence of this point with the anterior region of the child.

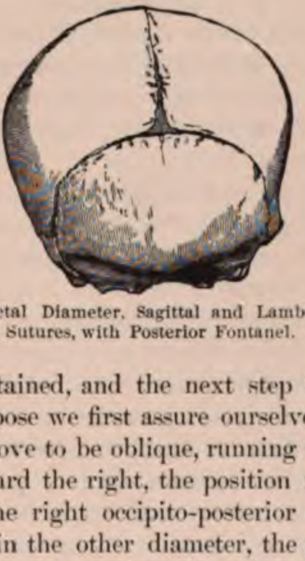
Supposing the labor has begun, if the finger be introduced through the cervix uteri, it will immediately encounter a rounded, smooth, and resistant surface, which is the anterior side of the head; and then, by directing the index a little farther upward and backward, in the direction of the sacro-vertebral angle, it will come into contact with a membranous interval; that is, with the sagittal suture.

FIG. 254.



Anterior and Posterior Fontanels.

FIG. 255.



Biparietal Diameter, Sagittal and Lambdoidal Sutures, with Posterior Fontanel.

A vertex presentation is now ascertained, and the next step is to make out the position. For that purpose we first assure ourselves of the direction of the suture, and if it prove to be oblique, running from before backward and from the left toward the right, the position must either be the left occipito-anterior or the right occipito-posterior one; but, on the contrary, if it be oblique in the other diameter, the position will either be the right occipito-anterior or the left occipito-posterior.

The direction being once determined, we have then only to find out where the occiput lies to complete the diagnosis; therefore, the finger by raising up the margin of the os uteri follows the sagittal suture until it reaches a fontanel.

## THE TREATMENT OF VERTEX PRESENTATIONS, BASED ON THE MECHANISM.

It is evident from our study of the mechanism of labor in vertex presentations, that the mechanism of the first position is the easiest and simplest form of mechanism possible, as, fortunately, it is the most common. The treatment, therefore, of labor when the child offers in the first position of the vertex is the treatment demanded in ordinary natural labor, and requires no further comment.

SECOND POSITION.—*Right Occipito-anterior Position.*—In the second position rectal accumulations might interfere with the descent and rotation of the head. A suitable enema would remove these, when the case would need only the treatment of natural labor.

THIRD POSITION.—*Occipito-pubic.*—We have seen that a third position usually becomes spontaneously converted into a first or second at the beginning of labor. The indications then are to favor this spontaneous conversion at the superior strait. This may generally be done by the finger acting on the forehead, so as to force the head into an oblique position. In a more difficult case the whole hand might be introduced, the head be grasped, and *during the absence of pains* gently pushed slightly up and loosened and placed in an oblique position, or the forceps could be applied and the same kind of manœuvre practised. Finally, in any instance where the head cannot be made to assume an oblique position at the superior strait (though a case of the kind must be considered almost a theoretical one), it will be necessary to secure perfect flexion of the head by the aid of the finger, hand, lever, or forceps. As soon as the cervico-bregmatic diameter (3½ inches) is made to offer to the 4 inches of the antero-posterior diameter of the superior strait, the head will pass without difficulty. In an occipito-pubic position, should the shoulders come down transverse, labor will be rendered easier by favoring rotation by pushing one shoulder into the hollow of the sacrum.

FOURTH POSITION.—*Right Occipito-posterior Position.*—Fortunately, as we have seen, the oblique occipito-posterior positions in almost every instance terminate by anterior rotation of the occiput. Nevertheless, even when this most desirable movement takes place spontaneously, the struggle between the forces of propulsion and resistance is always greater than in primitive occipito-anterior positions—usually, immensely greater. Consequently, labor is longer, more painful, and more dangerous to both mother and child. Hence most authorities advise that anterior rotation should be assisted, and thus the struggle be made shorter and less painful. Should such assistance be decided upon, it must be recollected that it is not to be attempted, in ordinary cases, until the head has reached the floor of the pelvis; in other words, until the head has reached that part of the pelvic cavity where rotation takes place naturally and spontaneously. Sometimes rotation can be secured by the finger alone placed on the side of the forehead. Usually, however, bipolar pressure is necessary; that is, one or two fingers can be placed on the side of the forehead and a lever be inserted over the side of the occiput. Often the best method is to apply the *straight short* forceps, secure rotation, and then complete the delivery by aid of this instrument.

None of these manipulations are to be done rudely or quickly; on the contrary, they should be kept up for a long time. Gentleness, not violent force, is essential to the safe and proper management of these often most difficult and trying cases. The head is rather to be *coaxed*, than compelled, to rotate.

Spontaneous rotation takes place much more easily and quickly in these cases when the bag of waters is not ruptured. Hence, should an occipito-posterior position be recognized during the first stage of labor, care must be taken to preserve the bag as long as possible—certainly until the occiput has come to the front.

It is asserted that the position of the woman on her right or left side (according as the case may be a right or left occipito-posterior position) favors signally spontaneous rotation. Hence the simplest and often best treatment is to preserve the bag of waters, and place the woman on her right or left side, and attempt nothing else until these have proved ineffectual. Constantly, however, the forceps will be found necessary, if not to secure rotation, at least to relieve a woman exhausted by prolonged effort, and a child in great peril from prolonged pressure.

The occiput, in spite of any or all of the assistance just recommended, sometimes goes into the hollow of the sacrum. I believe that in the great majority of such cases, when such posterior rotation takes place, *notwithstanding* all our efforts to prevent it, the case is really a sixth position—an occipito-sacral position; that the head early in the labor assumed an oblique position at the superior strait; that the body, however, did not participate in this movement, but was held tightly by the grasp of the uterine walls, with the back of the child's body looking directly to the spinal column of the mother; that the medical attendant diagnosed (he could not do otherwise) an *oblique* occipito-posterior position of the vertex: he has attempted to secure rotation, and has failed, not because his manipulations were not skilfully rendered, perhaps, but solely for the reason that the walls of the uterus grasped the body of the child so tightly that the head could not even be forced to rotate. I believe that in all cases, where a normal head fails to rotate on a normal perineum, the trouble is a sixth position. The occiput then sometimes, in spite of every effort to prevent it, goes into the hollow of the sacrum, and the result is, if the head be large or the soft parts rigid, often one of the most difficult cases in obstetrical surgery. In these cases of posterior rotation, unless the child be small, the pelvis capacious, the soft parts relaxed, and the *voluntary powers* great, we need not expect the labor to terminate, spontaneously, safely to mother and child. An impacted head for only three or four hours may prove quite sufficient to cause sloughing of the maternal parturient surfaces, with all the subsequent horrors that such sloughing suggests, from puerperal septicæmia down. At the same time, the cerebral centres of the child may undergo dangerous or fatal compression.

My earnest advice, in all difficult cases of this kind, is not to hesitate or vacillate or delay, but promptly to furnish assistance. A pair of *short, straight* forceps should be applied *immediately*, and a firm but prudent attempt be made to *force* (the time for coaxing has passed) a rotation of the occiput to the pubis. In doing this we transgress the rule not to force the child's head to rotate more than a quarter of a circle, for fear of dislocating its cervical vertebræ. But we are justified in this heroic procedure by the fact that the child's chances are greater, delivered even by this highly dangerous method, than if the case were not interfered with, while the mother is saved a most perilous labor. Should this attempt at *forced* rotation fail—and probably it will fail—then the delivery may be secured possibly by traction with the forceps, though the occiput remain in the sacrum. The forceps here must be used with the greatest care and prudence, and even when most skilfully employed may be insufficient to accomplish delivery; or, if delivery be secured by it, the pressure necessary is often so great that the child is stillborn, or its cerebral centres so damaged that it speedily perishes, or, what is worse, survives as a paralytic idiot, or, still worse, attains maturity with a mental and physical organization more or less imperfect, the result directly of the difficulties attending its birth.

Should a *prudent* application of the forceps fail—and it constantly will fail—then the forceps must be abandoned. The forceps in any difficult case of labor must only be used as a conservative instrument. When violence or improper force is resorted to, the forceps ceases to be a conservative instrument, and becomes a highly dangerous one—often as fatal to the child as a pair (which it actually becomes) of crushing craniotomy forceps, and much more dangerous than these to the mother. When we abandon the forceps, however, we do not abandon for one moment our patient. We do not think of "waiting and trusting to Nature;" there can be no rest until labor is completed. The child is practically lost, and every minute of delay lessens the chances of the mother. The next procedure is embryotomy; and this is not to be slowly thought of, and still more slowly performed; but if it must be done, it must be done immediately.

We sometimes hear embryotomy spoken of as a barbarous operation, as an operation never justified, as an operation which in the future will be banished from obstetrical practice. Such opinions can only be entertained by men who have had absolutely no experience in difficult cases of labor, and particularly in the kinds of cases now under consideration. Here embryotomy, instead of being a barbarous operation, becomes a highly conservative and benign one. The child is lost; the forceps have proved powerless to save it. Delay means *certain* disaster, probably death, to the mother. Embryotomy does not kill the child; the impossible labor kills it, and embryotomy saves the mother. Embryotomy, prudently performed, in these cases is not dangerous—is not to be compared to the danger of the injudicious use of the forceps, while it at once places the mother in safety. My earnest advice is, in the case under consideration, to resort immediately, after failing with the forceps, to embryotomy. More than this: I consider the practitioner who fails to give the mother this last chance is *criminal* in his ignorance or his timidity. Never be too timid to save your patient's life. The greater the emergency, the greater the heroism demanded to meet it. The "trust-to-Nature" practice here means *murder*, and the timid and vacillating practitioner is accountable for the tragedy which surely follows such practice. The man who is too pusillanimous to shoulder grave responsibility in the hour of great peril is not fit to practice obstetrics.

A consultation should now be called, since no medical man, no matter what his position or age in the profession may be, would be justified, unless the urgency was very great and a speedy consultation impossible, in performing embryotomy on a living child without one. As soon after consultation as practicable the head should be opened and the case terminated.

But suppose—as is by no means unlikely—the medical man, called in consultation, demurs, suggests delay, trusting "a little longer" to Nature, or says the operation is unjustifiable and unnecessary: what is to be done? I then advise that the dangers be stated to the patient and her friends, a free and candid opinion being given as to the necessity of an immediate operation. If they decide against the operation, instantly abandon the case. If you continue in it, you countenance a management that must have a disastrous termination, and you will have to bear your share of the odium sure to attach to the medical men who mismanage their cases to fatal or unfortunate results.

FIFTH POSITION.—*Left Occipito-posterior Position.*—The treatment of the fifth position, as well as the treatment of the sixth, must be the same as that just recommended for the fourth position, and therefore needs no further discussion.

### DEVIATED OR IRREGULAR PRESENTATIONS OF THE VERTEX.

Perfect flexion of the head gives a vertex presentation. Sometimes, however, the head is not perfectly flexed, and then, instead of the cervico-bregmatic circumference, the occipito-frontal, with its 4-inch diameter, becomes involved. We have seen that the occipito-frontal circumference is common in vertex presentations before labor actually begins, since the head reposes at the mouth of the uterus, not perfectly flexed; and we have also seen that one of the earliest changes of labor is to complete the flexion of the head, and bring the vertex fairly to offer. In some rare cases, for reasons not always evident, this desirable flexion fails to take place, and we have what some authors describe as a distinct presentation.

PRESENTATION OF THE ANTERIOR FONTANEL.—Instead, however, of describing a distinct presentation of the anterior fontanel, I think the subject is simplified, and much more readily understood and recollected, by discussing it as a deviation from a vertex presentation. In any of the six positions of vertex presentations complete flexion may not take place, and a so-called presentation of the anterior fontanel is the result. Should the position be a third or a sixth, there would be an arrest of the head at the superior strait, since four inches (the occipito-frontal diameter) cannot pass through four inches, the antero-posterior diameter of the superior strait.

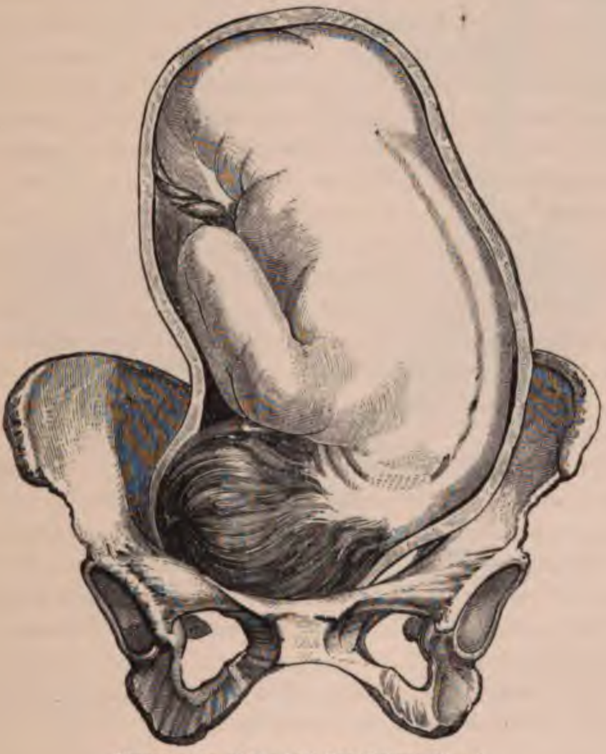
In the oblique positions of anterior fontanel presentations, the occipito-frontal diameter could pass readily through either the oblique (5 inches) or the transverse (5¼ inches) of the superior strait, but would be arrested at the inferior strait by its four-inch diameter.

The indication for treatment, in all cases of the kind now under discussion, evidently is to secure flexion; in other words, to convert a deviated vertex presentation into a complete vertex, and to cause the cervico-bregmatic circumference, with its three and a half inches of diameter, to offer instead of the occipito-frontal circumference, with its longer four inches of diameter.

Flexion is to be secured by the finger or lever, or both. A finger may be placed on the forehead, and may be kept there, and thus, often, gradually, complete flexion may be secured; or, a lever may be slipped over the occiput, and the back of the head be well brought down; or both of these manœuvres may be employed simultaneously. In occipito-posterior positions of anterior fontanel presentations the indications are to secure anterior rotation of the occiput, and, at the same time, cause the head to flex. When the forceps is demanded, it is highly important that the head should, if possible, be completely flexed before tractions are made.

INCLINED PRESENTATIONS OF THE VERTEX.—*Presentations of the Sides of the Head.*—Sometimes, in rare instances, the child offers by the side of its head. An ear or one parietal protuberance is found at the centre of the superior strait instead of the vertex. Such cases have been described as distinct presentations; but, for reasons already given in discussing presentations of the anterior fontanel, I think it more advantageous to describe them as deviations from a vertex presentation. Presentations of the side of the head undoubtedly are caused by obliquities of the uterus. Either side of the head may offer. If the presentation should persist, the difficulty is that the occipito-mental circumference, with its five-inch diameter, offers at the superior strait, and the head is arrested. Luckily, the occiput may slip into the cavity of the pelvis, the head flex, and a fair vertex presentation terminate the labor. Should this favorable spontaneous termination not happen, the head remains arrested and labor becomes impossible.

FIG. 256.



Presentation of the Left Ear (Ramsbotham).

The indication for treatment of labor in a presentation of the side of the head *is not* to "trust to Nature" or to wait for a spontaneous termination. Assistance should be *immediately* given, since all assistance is more easily rendered early in labor, but becomes more difficult and painful as time elapses; while early assistance saves the mother and child from present suffering and future danger. The indications are to restore the vertex. Should the patient be seen early in labor, before the rupture of the bag of waters and before the head has escaped from the mouth of the uterus, and should the attendant be an experienced operator, version by the feet might be a possible proper treatment. I should not hesitate myself to perform it under the above circumstances. Under any circumstances version by the vertex would be indicated, the hand to be introduced, fingers to the sacrum; the head grasped, and pushed up during the absence of a pain; the fingers are now to be slipped over the occiput and the vertex brought down. Should this manœuvre prove impossible—and it is much more difficult than it *sounds*—a *bimanual* version of the vertex may be attempted. One or two fingers may be placed on the side of the neck or about the mastoid process, while the other hand presses on the head from the outside and through the abdominal walls. A simultaneous pressure by both hands will sometimes cause the head instantly to change its position, and a complete vertex presentation is at once secured. Finally, the lever, inserted over the head, sometimes quickly and easily removes the difficulty.

Should all of these attempts fail, the forceps may be resorted to. The blades should be applied to the sides of the pelvis, and the head should be grasped as accident determines. Careful traction should be made. Of course the five inches of diameter cannot pass, but the traction seems at times to loosen and dislodge the occiput, which finally descends, flexes in the grasp of the instrument, and the case is terminated successfully.

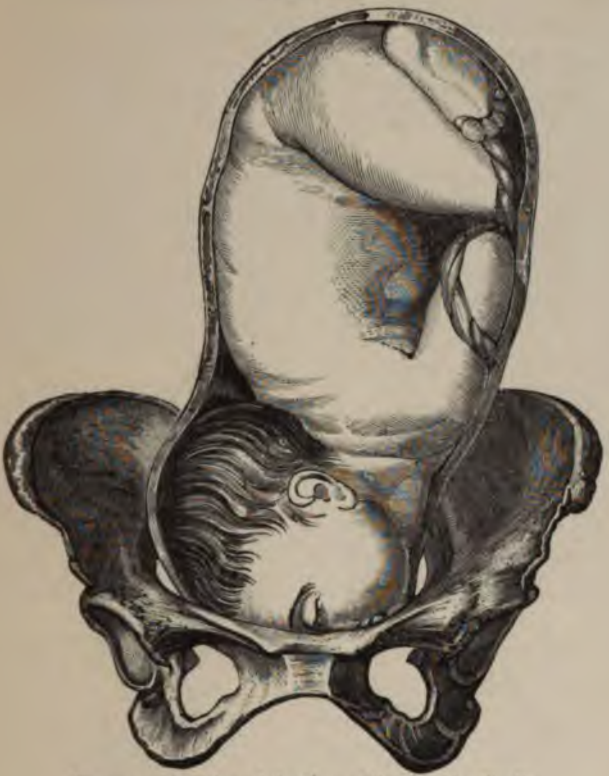
Should the forceps fail, nothing is left but craniotomy, and the sooner this is resorted to the better for the mother.

## FACE PRESENTATIONS.

Complete flexion of the head causes the vertex to present; complete extension of the head causes a face presentation. Face presentations are not common; they occur once in about 250 cases of labor.

The ordinary cause of face presentations is obliquity of the uterus: the vertex strikes on the edge of the strait and is arrested, and the face descends. Cases are reported where, in post-mortem examinations made on women dying at full term, the dead fœtus has been found in the womb offering by its face. I believe that in all such instances the child has been convulsed before or at the moment of its dissolution, and the condition of opisthotonos has placed the head so as to cause the face to present. It seems highly probable that a primitive face presentation in a living child is the result of similar causes; that is, that such a prim-

FIG. 257.



Transverse Position of the Face at the Superior Strait.

itive face presentation is caused by some attack of convulsions in the fœtus occurring shortly before labor.

## MECHANISM OF LABOR IN FACE PRESENTATIONS.

Not to confuse the reader, we will consider in our description of the mechanism of labor in face presentations the same number of positions we studied in vertex presentations; that is, six positions. In three of these positions the chin is turned to the anterior part of the pelvis, and we term them mento-anterior positions. In three the chin is turned to the posterior part of the pelvis, and we term them mento-posterior positions.

FIRST POSITION OF FACE.—*Left Mento-anterior Position.*—The chin looks to any part of the left anterior inclined plane.

SECOND POSITION.—*Right Mento-anterior Position.*—The chin looking to any part of the right anterior inclined plane.

THIRD POSITION.—*The Mento-pubic Position.*—The chin at the symphysis.

FOURTH POSITION.—*Right Mento-posterior Position.*—The chin in relation with the right posterior inclined plane.

FIFTH POSITION.—*Left Mento-posterior Position.*—The chin in relation with the left posterior inclined plane.

SIXTH POSITION.—*The Mento-sacral Position.*—The chin directly to the sacrum.

The most common position of the face is the second, the chin to the right anterior inclined plane. This we would naturally infer when we bear in mind that a left occipito-anterior position of the vertex—the common position in vertex presentations—would be converted by uterine obliquity into a face presentation, with the chin looking to the right side of the pelvis. We may study, therefore, the mechanism of this second position of the face as the typical mechanism.

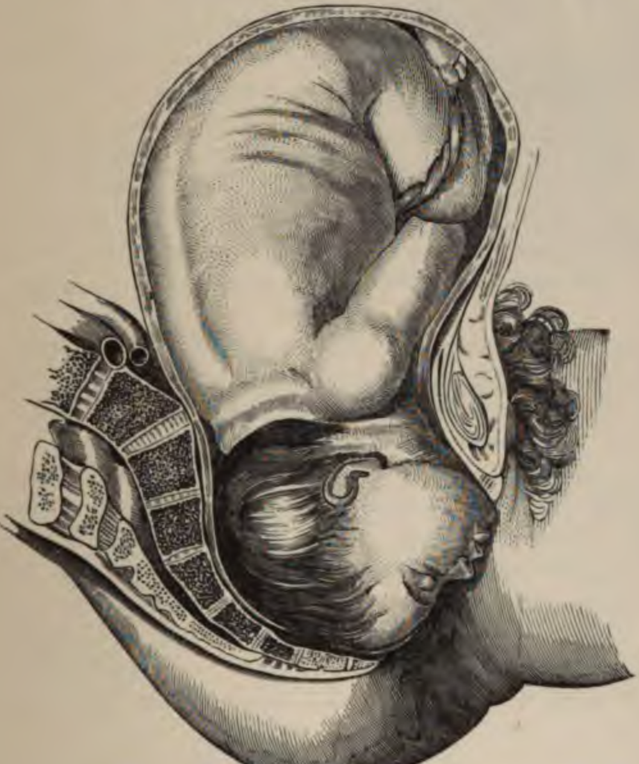
Before the rupture of the membrane, the head, as a rule, is not completely extended, and the forehead offers rather than the face—a condition analogous to that which we have studied in a vertex presentation before the escape of the liquor amnii. When the bag of waters ruptures, owing to the circumstance that the presenting part does not fit so completely the os uteri as it does when the vertex offers, the whole of the liquor amnii usually escapes, and the walls of the uterus grasp the fœtal body.

The first effect of uterine contraction, after the rupture of the bag, is to complete the extension of the head (adaptation). In a vertex presentation, adaptation means flexion. The extension of the head causes the face fairly to offer at the superior strait, and we have two circumferences to study—viz. the fronto-mental circumference, which is the apparent circumference involved, and the trachelo-bregmatic circumference, which is actually the real and important circumference after the face descends into the cavity.

The fronto-mental circumference has its largest diameter, the fronto-mental diameter (3 inches), the trachelo-bregmatic diameter being 3½ inches. We have, therefore, at the superior strait, in a right mento-anterior position, these two diameters, successively, in relation with the oblique or transverse diameters of the brim (5 and 5¼ inches): the biparietal diameter (3½ inches), being in relation with the oblique of the opposite side, or the antero-posterior (5 and 4 inches), the occipito-frontal diameter being more or less in the axis of the superior strait. As there is ample room at the brim, the face engages and descends only as far as it can descend; that is, only as far as the length of the neck will permit it to descend.

In an occipito-anterior position of the vertex, we have seen that the occiput descends from the superior strait to the floor of the pelvis without changing its position. But in a face presentation this can only take place at the symphysis pubis, since a complete descent of the face in any other position implies either that the length of the anterior part of the child's neck is sufficient to reach from the brim to the outlet, a distance of 3½ inches at the sides of the cavity, or that there should be a simultaneous engagement of the extended head and the upper part of the trunk—an impossibility in a fœtus of normal size. The face now descends, the chin on the right anterior inclined plane, only as far as the length of the neck will permit, when it is arrested and can advance no farther. Now, usually (often after great delay), the chin, resting on the obliquely inclined surface of the anterior inclined plane, receives sufficient force of resistance to cause it to rotate to the symphysis pubis. At the symphysis pubis, as we have just stated, the depth of the pelvic cavity is one and a half inches; therefore at the symphysis pubis, and here alone, is the child's neck long enough to measure from the superior to the inferior strait. The chin now is pushed under the arch of the pubis, and the anterior part of the neck is pressed closely against the symphysis. Presently the chin can advance no

FIG. 258.



Face Presentation, Chin anterior, at the Inferior Strait.

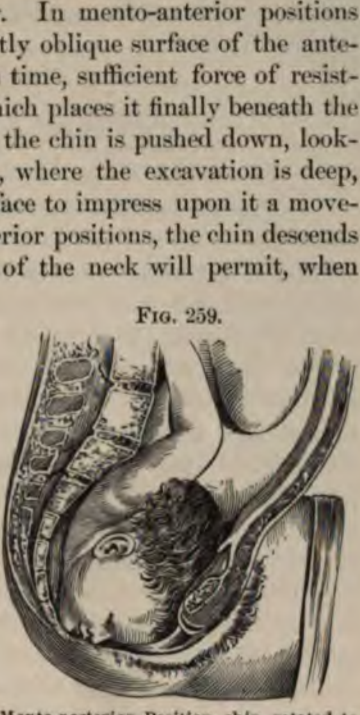
farther, and becomes locked beneath the arch, the anterior part of the neck resting on the subpubic ligament. Here we have a situation exactly analogous to that which we studied in vertex presentations, when the perfectly flexed head rotated, and the occiput went under the arch, and the back of the neck pressed strongly against the symphysis pubis, the nape of the neck resting on the subpubic ligament, and the occiput locked beneath the arch and unable to advance. In a face presentation, after rotation of the chin to the symphysis, we find a perfectly extended head, the chin under the arch, the pretracheal region resting on the subpubic ligament, and the chin locked and unable to advance.

Now, still following the analogy we have witnessed in vertex presentations, the occiput, which has been, in consequence of the extension of the head, pressed firmly against the back of the child, under the influence of the expelling forces, the chin being locked, leaves the back, sweeps through the hollow of the sacrum and through the hollow of the distended soft parts, and finally the head is born by a process of flexion, the anterior part of the neck resting, as a point of support, on the subpubic ligament, and the occiput describing round it the arc of a circle having for its radius the trachelo-bregmatic diameter (3½ inches), while the occipito-frontal diameter is, more or less, in the axis of the outlet. In a face presentation, after the expulsion of the head, the body is delivered by a mechanism similar to that in vertex presentations.

The left mento-anterior position has a mechanism identical with that just described for the right mento-anterior. The mento-pubic position, as an occipito-pubic of the vertex, would tend to be spontaneously converted at the superior strait into an oblique position. Should this change not occur, the mento-pubic ought to prove, provided the head be perfectly extended, the easiest of the mento-anterior positions, since the chin enters the superior strait, where the length of the neck can reach from the brim to the outlet, and rotation—the great difficulty, as we shall presently see, in all oblique face presentations—is not necessary. In a mento-pubic position the chin simply sinks down along the inner face of the symphysis pubis, becomes locked under the arch, and labor terminates, as in the other mento-anterior positions, by flexion of the head.

*Mento-posterior Positions.*—The mechanism of labor in mento-posterior positions can be stated in few words. Let us take the fifth position of the face as the typical position, the chin to the left posterior inclined plane. We have, at the superior strait, the same 3 and 3½ inches of diameter that we have already studied in the mento-anterior positions, and therefore there is nothing to prevent the speedy descent of the face. The face descends as far as the length of the child's neck will allow, and no farther. In mento-anterior positions the chin, resting on the hard and slightly oblique surface of the anterior inclined plane, secures generally, in time, sufficient force of resistance to cause the diagonal movement which places it finally beneath the arch; but in a mento-posterior position the chin is pushed down, looking to one of the sacro-iliac symphyses, where the excavation is deep, and where it can meet no resisting surface to impress upon it a movement of rotation. Hence, in mento-posterior positions, the chin descends quickly and easily as far as the length of the neck will permit, when it is arrested, and labor becomes impossible. In rare instances, after a long struggle, some point of resistance might be afforded, and then an anterior rotation of the chin and a spontaneous termination might be possible. But such anterior rotation is not to be expected, and we are justified in declaring that *all mento-posterior positions* are to be considered as *practically impossible* positions, and are *never to be trusted to Nature*, but are to be *immediately assisted*.

Fig. 259.



Mento-posterior Position, chin rotated to sacrum.

Face presentations are not only tedious and difficult (even those where the position is favorable), and sometimes, as we have just seen in mento-posterior positions, impossible, but they are often dangerous or fatal to the child. The danger to the child is due to compression, all through labor, of the blood-vessels of the anterior part of the neck, producing a cerebral plethora and a disposition to convulsions. This danger to the child should never be forgotten, and labor may demand speedy termination often solely on its account. It must also be borne in mind that the face of the fœtus becomes the seat of the caput succedaneum, and hence, when labor is tedious, the child at birth presents often an appearance that greatly shocks and frightens the parents and friends. Its face is almost or quite black, its cheeks are swollen, its lips are turned in, and the nose scarcely visible, while the face, in addition, is often wounded and scratched by the examining finger of the impatient and anxious medical attendant. It is well to state beforehand to the friends the probability of such terrifying appearances, and also to assure them that a few days will remove all traces of these peculiarities. A child born by a face presentation exhibits a marked tendency in its head to fall back whenever all support is withdrawn. This phenomenon is due to the prolonged pressure upon and stretching of the sterno-cleido-mastoid muscles, and will also spontaneously disappear in two or three days.

### DIAGNOSIS OF FACE PRESENTATIONS.

(*Cazeaux.*)

The diagnosis of face presentations is made out more or less easily according to the period of labor at which the examination is made. Before the membranes are ruptured, the head in general is high and difficult of access, so that it is almost impossible to reach the presenting portion, provided the membranes are the least tense. Again, the reversion of the head not being yet completed, the forehead is the lowest part, and the one the finger encounters in performing the touch; whence by feeling a hard, rounded body furrowed by a membranous interval (the coronal suture), we might very readily mistake it for a vertex presentation. But if the flaccid and folded membranes can be depressed without difficulty, or, still better, if they have been recently ruptured, the diagnosis becomes easier. Then we find toward one side of the pelvis a rounded, solid surface, the forehead, traversed by a suture leading to a transverse depression; next a triangular elevation whose base, looking in an opposite direction from the forehead, exhibits two openings, the nares, and beyond this a transverse fissure bounded by the superior and inferior maxillary arches. Sometimes the finger when introduced into the mouth of the child has been clearly sensible of an effort at suction. On the sides of the median protuberance, two little soft tumors (the eyes) are felt, surrounded by an osseous circle; and, lastly, when the head is low down, an ear may be detected behind the pubis.

When the presentation is once determined, the position is easily made out, for the opening of the nostrils must evidently look toward that part of the pelvis which corresponds with the chin. When a long time has elapsed after the rupture of the membranes new causes of difficulty are met with. Thus, the face, which now corresponds to the open space in the pelvis, becomes the seat of a considerable tumefaction, due to the same cause which produces the tumor of the scalp in vertex presentations. The cheeks, being greatly swollen, and at the same time compressed on the sides, project and lie close to each other in front, thus leaving a deep fissure between them, in the bottom of which the distinctive characters of the face are entirely concealed; this fissure might very readily be mistaken for the one between the nates, which are then confounded with the tumefied cheeks. Further, the lips are also swelled, wrinkled, and everted in such a manner as to offer a rounded orifice, instead of the usual transverse fissure; and this orifice has been mistaken in some instances for the anus; hence in such cases a careful examination seems to be necessary to avoid an error which has not unfrequently been committed.

## THE TREATMENT OF FACE PRESENTATIONS.

It is remarkable that there is the greatest diversity of opinion among writers and teachers on this subject; and it is lamentable that, in consequence doubtless of this diversity of opinion, as well as also from a want of clear and definite conceptions of the physiology and treatment of these presentations, medical men are often totally ignorant of their proper management. It has been my lot to meet with several instances where respectable and well-educated men have conducted cases of face presentations so ignorantly and improperly that the lives of both mothers and children were lost.

Some authorities hold that face presentations are cases of unnatural labor and usually demand prompt interference, while others assert that they are cases of natural and easy labor and require no assistance.

A recent writer on Obstetrics, in discussing face presentations, after describing a mechanism, says: "All of which takes place with no greater difficulty than in an ordinary cranial position;" farther on he remarks: "We have attempted throughout in the description to indicate the strong analogy which exists between them and the ordinary positions of the cranium."

In suggesting a new and most important principle in the management of face presentations—a principle, too, based on what I consider the *only* correct theory of their mechanism—it becomes necessary to test these views, since my experience compels me to differ from them entirely. I hold that a face presentation is much more difficult and much more dangerous than "an ordinary cranial position," and that there is no more analogy between a face and a vertex presentation, either in mechanism or in any other respect, than there is between a trunk presentation and "an ordinary cranial position."

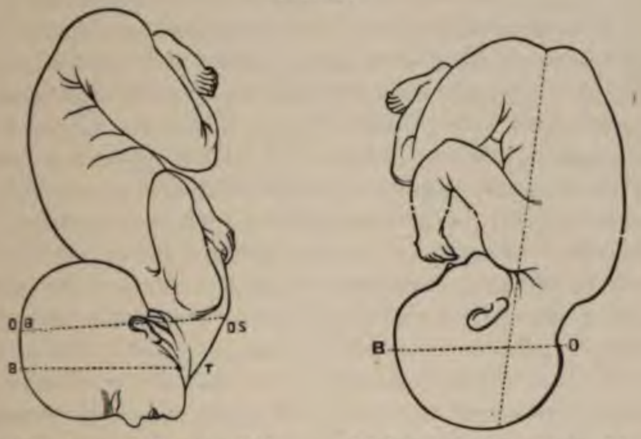
Can this assertion be sustained?

In a vertex presentation—I mean by a vertex presentation where the head offers completely flexed—we find the most favorable cranial diameters presenting: viz. the diameters of the occipito-bregmatic (cervico-bregmatic) circumference, three and a half inches in each direction; coinciding with these most favorable diameters there is also, in vertex presentations terminating by anterior rotation of the occiput, the perfect and complete co-operation of all the parturient forces to accomplish easily and safely the expulsion. The advancing vertex receives the force of parturient actions, through the spinal column, *in almost a direct line;* without difficulty it reaches the floor of the pelvis; here it meets the force of resistance, which in due time secures that rotation to the arch of the pubis essential in most cases to the spontaneous termination of labor.

Now, what are the conditions in a face presentation? Take, as an example, a case where the chin offers toward the right acetabulum (the right mento-anterior position). The cranial diameters involved in a presentation of this kind are extremely favorable; indeed, though different, they possess precisely the measurements of the diameters concerned in a vertex presentation; they are the diameters of the trachelo-bregmatic circumference, measured from the anterior edge of the foramen magnum to the posterior angle of the anterior fontanel, three and a half inches in each direction. How is it, then, if the cranial diameters involved in a face presentation are so favorable, I can maintain the assertion just made, that there is no analogy whatever between a face and a vertex presentation? In the first place, there is not the slightest resemblance in the mode of action of the propelling forces. In vertex presentations, as I have remarked, the advancing occiput receives in a direct line, through the spinal column, the parturient forces. In a face presentation, the head being completely extended, the force of the parturient actions is communicated to the advancing face, not in a direct line, but through the cervical vertebræ *bent at a right angle;* hence the face, instead of being propelled promptly by well-applied and well-directed force, is rather made to advance slowly and uncertainly by *being dragged after the neck*—in other words, made to advance slowly and uncertainly by the action of parturient forces applied, not in the best possible manner, as in vertex presentations, but in the worst and most inefficient manner possible, involving an enormous loss of the expelling force, with the necessary result of greater delay and the grave consequences which this greater delay always implies. Certainly here we recognize no analogy or resemblance between the face and vertex presentations.

Again, in a vertex presentation the occiput, receiving the entire force of the parturient expelling effort, easily and speedily reaches the floor of the pelvis, where it meets usually the force of resistance, and anterior rotation is secured. In a face presentation, in spite of the most favorable cranial diameters offering, the very reverse is witnessed. The face, engaging, descends into the cavity of the pelvis; but how far does it descend? The writer whom I have quoted says it descends "until the face reaches the floor of the pelvis." Is this statement correct for a case at term and where normal diameters are involved? In the position I have taken as an example—viz. where the chin offers toward the right acetabulum—the face descends, the chin passing down the right ischiatic plane, only, however, as far as the length of the child's neck will permit—that is, only for about an inch and a half; but the depth of the pelvic cavity at this spot—viz. the right acetabulum—is three and a half inches, and the chin *cannot* descend to the floor of the pelvis, because to do so will require either that the child's neck shall become elongated to an extent impossible, or that there shall be a simultaneous engagement of the head and of the upper part of the trunk in the pelvic cavity. But the occipito-bregmatic diameter is three and a half inches, and the dorso-sternal diameter is three inches, together six and a half inches, and six and a half inches cannot engage in any part of the superior strait. Hence the chin in face presentations cannot reach the floor of the pelvis at the lateral or posterior part of the pelvic cavity, but can only descend as far as the length of the child's neck (an inch and a half) will permit. Here, too, we again fail to detect the slightest analogy between face and vertex presentations.

FIG. 260.



*O-B*, occipito-bregmatic diameter, 3½ in.
*T-B*, trachelo-bregmatic diameter, 3½ in.

*DS*, dorso-sternal diameter, 3 in.
*OB*, occipito-bregmatic diam., 3½ in.
6½ in.

The face, having descended into the pelvis as far as the length of the neck permits, necessarily can advance no farther, and the head is arrested, and labor can only terminate spontaneously by the chin coming to that part of the pelvic cavity where the child's neck *is* long enough to reach from the superior to the inferior strait; that is, to the symphysis pubis, at which point the depth of the pelvic cavity is but an inch and a half. In the majority of cases of face presentations this essential anterior rotation of the chin ultimately occurs; if, however, rotation should not take place, labor becomes impossible, save in cases so rare and exceptional that they are not to be expected.

All writers on the subject agree that face presentations, even when terminating spontaneously by anterior rotation of the chin, usually are extremely tedious. Why are they tedious? My answer to this question and the treatment suggested by the answer are what I claim as new and original points in these interesting presentations. Perhaps I can elucidate the subject best by an illustrative case:

Many years ago I was asked to see a woman who had been in difficult labor for twenty-four hours. The patient was a powerful woman, of uncommon strength and muscular development, possessing also a capacious pelvis. This labor was her fourth; her former confinements, in consequence of the conditions to which I have referred, had been rapid and easy, terminating in a few hours with little pain and no difficulty. Now, however, she had been in active labor for twenty-four hours, and her medical attendant was exceedingly apprehensive as to the result. On examination I found the child offering by its face, the chin directed to the left ischiatic plane. It was a fair, typical case of face presentation. As the woman had been in labor for twenty-four hours, I determined to apply the forceps immediately, but after several unsuccessful efforts to secure parallelism between the blades, so as to accomplish the locking of the branches safely, I abandoned the attempt. The woman's condition, notwithstanding her twenty-four hours of active labor, was good, and all the circumstances of the case appeared most favorable—viz. chin to plane of ischium, capacious pelvis, child of normal size, and the parturient forces unusually powerful. We decided, therefore, to wait and give *Nature* a longer trial. Twelve hours later I found the face precisely where I had left it in the morning; the chin had descended perhaps half an inch, more or less, along the plane of the ischium, but not a line had it advanced toward the pubis, and this in spite of the most tremendous uterine and voluntary efforts, frequently repeated, that I have ever witnessed. Evidently, no time was to be lost. The woman was rapidly becoming maniacal as a result of her immense but absolutely futile struggles. Again I applied the forceps; again met the same difficulty I had experienced in the morning; again abandoned the attempt. At this moment of excitement and trial, of anxiety and disappointment, with the cries and groans of the wretched and hopeless woman crowding my ears, I endeavored to solve the problem, Why does the chin not come to the symphysis pubis and the labor terminate spontaneously? The pelvis is of ample size; the face fairly presenting and not too large; the forces are immense; and yet Nature has failed, after thirty-six hours of violent labor, to accomplish delivery.

Suddenly and without warning the illumination came to me; the solution of the problem flashed into my mind, and with the most perfect faith I followed the leading which the new light revealed to me. The revelation was this: The child's chin does not come to the front because it can descend only an inch and a half into the pelvic cavity; if it could but reach the floor of the pelvis, then it would at once have impressed upon it a powerful force of resistance in consequence of the immense parturient efforts, and anterior rotation would be speedily accomplished. But it cannot reach the pelvic floor to secure this essential *point d'appui* in order to accomplish rotation. Why not, then, apply a force of resistance, and thus artificially furnish the essential *point d'appui?*

In far less time than I have occupied in writing these few lines, I proceeded to act on my new teachings. I applied a blade of the forceps on the posterior cheek. *I did not attempt to force a rotation of the chin;* I merely held the blade firmly against the side of the face in order to ascertain whether my reasoning was correct. To my utter amazement, this face, which had been so immovable for thirty-six hours, not slowly, not after the lapse of some minutes, but almost instantly responded, the chin swept across the plane of the ischium, slipped under the arch of the pubis, and in *less than five minutes* the child was born.

This, then, is the new point I make: face presentations, as we have seen, are almost always tedious, sometimes painfully so, sometimes fatally so, because the face cannot, save in exceptional cases, reach the floor of the pelvis, where alone it can receive that complete force of resistance which in vertex presentations secures ready anterior rotation. But, it may be urged, face presentations do terminate, usually, spontaneously by anterior rotation of the chin. This is true. The chin, after descending an inch and a half, *may receive* a feeble, imperfect, and badly-applied force of resistance from the slightly-inclined side of the pelvic cavity on which it rests; which imperfect force, after many hours perhaps of delay and suffering, *may* bring it slowly, strugglingly, uncertainly to the symphysis pubis. But these hours of delay are not devoid of grave peril both to the mother and the child. During the whole of the second stage of labor in a face presentation the anterior part of the child's neck is exposed to more or less pressure, and if this pressure be prolonged, cerebral congestion, or even cerebral effusion, may be the result, and convulsions or death the ultimate consequence. Statistics show that in face presentations, even when terminating spontaneously by anterior rotation of the chin, one child in ten perishes, and when anterior rotation does not take place scarcely any survive.

If the views which I have given be correct, it is evident that there is no resemblance of any kind between face and vertex presentations, and it is also evident that they demand totally different treatments.

Vertex presentations where the occiput comes to the arch of the pubis are the most favorable of all presentations, as, fortunately, they are by far the most common, and, as a rule, neither require nor admit of any treatment. Face presentations, on the contrary, even when the chin is originally directed toward the sides or the anterior parts of the pelvis (mento-anterior positions)—in other words, even in those cases considered by many writers as cases of natural labor—never, as a rule, should be trusted to Nature, but should always be assisted. Happily, when the principles of mechanism on which it is based are understood, the assistance needed is as simple as it is easily applied; but when applied, as in the very interesting case I have related, this very simple procedure will cause a labor to terminate many hours sooner than it otherwise would have done, or will render a labor, which might have proved impossible without it, speedy and easy.

The assistance which I advise in all cases of face presentations of mento-anterior positions is, as soon as the mouth of the uterus is dilated and the face has fairly engaged, to apply the hand, the lever, or the blade of the forceps to the posterior cheek; in other words, to bring artificially a force of resistance to bear on the face, inasmuch as the face, for the reason I have already given, cannot secure this force of resistance from the tissues of the pelvic floor, as the vertex does in vertex presentations, and therefore the chin does not rotate, or does so slowly and uncertainly, to that part of the pelvic cavity where a spontaneous termination of labor is alone possible. If the medical attendant apply this force of resistance at the time and in the manner I have directed, rapid rotation will be secured and the labor will terminate speedily and safely. If this artificial force of resistance be not applied, then Nature may terminate the case spontaneously, but often not until many hours of useless suffering on the part of the mother, and many hours of perhaps dangerous pressure on the cervical vessels of the child have been passed.

In summing up, then, the whole treatment of face presentations, I will say that, for the reasons just given, they are never to be trusted to Nature. In mento-anterior positions the treatment I have described should be resorted to. If, however, the chin be turned to the posterior part of the pelvis (mento-posterior position), we have one of the gravest cases in obstetric surgery to deal with. Anterior rotation of the chin under these circumstances is possible, but so exceedingly improbable that we have no right to expect it, and we should, as soon as the difficulty is recognized, treat the case as one of impossible labor. If seen in time—that is, if seen *before* the presenting face has passed the mouth of the uterus—I am convinced that the safest and best treatment is to resort promptly to version by the vertex or version by the feet. But either of these methods of procedure must be restricted by the conditions I have laid down; that is, the presenting face must not have passed the mouth of the uterus; should it have done so, version either by the vertex or by the feet involves such great risks of laceration that I consider it entirely unjustifiable; and I can never endorse a treatment recently proposed which consists in placing the woman under complete anæsthesia, and then forcibly flexing the head, converting the impossible mento-posterior position of the face into the natural occipito-anterior position of the vertex. Twice have I known forced version, performed under *complete anæsthesia*, cause speedy death in consequence of laceration of the uterus. Should, therefore, the presenting face have passed the mouth of the uterus, version of any kind cannot safely be attempted. An endeavor may now be made to *force a rotation* of the chin to the symphysis pubis, either by the forceps, the lever, or by placing the finger in the mouth. *Under no circumstances* should the forceps be used to try to deliver the head with the *chin to the sacrum.* Such attempts must prove fatal to the child, expose the mother to frightful risks, and, moreover, will be found unavailing.

Should, then, in any case of face presentation where the chin is posterior, version by the vertex or version by the feet be not permissible, should all attempts to secure forced anterior rotation of the chin by any of the expedients I have mentioned have proved unsuccessful, then there is but one *safe* expedient left, and that is to perform craniotomy. And this, in such cases, *conservative operation* should not be deferred until the mother is so exhausted by her prolonged efforts that she has lost most of her chances of surviving, or so damaged by ignorant and rude attempts to deliver the child along the sacrum (I have known several such cases) that any proceeding is almost hopeless; but a consultation should be called, if one is not already in charge, and, should embryotomy be determined on, the operation should be done at once. The child's viability is destroyed; it is, though alive, practically dead, and all our efforts should be directed to secure for the suffering woman a delivery as speedy and safe as may be.

## Deviated or Irregular Face Presentations.

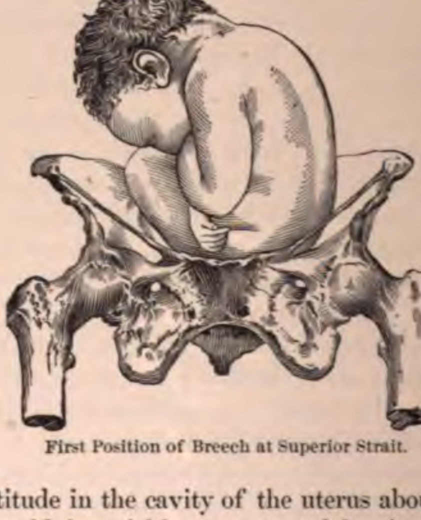
Perfect flexion of the head gives a vertex presentation; partial flexion of the head gives a deviated vertex presentation or a presentation of the anterior fontanel. Perfect extension of the head gives a face presentation; partial extension of the head gives a deviated or irregular face presentation; in other words, partial extension of the head gives a brow presentation. In brow presentations we have the parieto-mental or the occipito-mental circumferences offering at the superior strait (4½ and 5 inches); the head is arrested and labor becomes impossible. Brow presentations, therefore, as such, are impossible cases of labor; they are never to be trusted to Nature, and are always immediately to be assisted.

The indications for treatment depend absolutely on the position. If the occiput be in front, the indication is to flex the head and convert an impossible brow into a most easy occipito-anterior position of the vertex (to convert it into a face presentation would be to convert an impossible brow into an impossible mento-posterior position of face). Should the occiput be behind, the indication is to extend the head, and convert an impossible brow into a face presentation of the most favorable position (to convert it into a vertex would be to convert it into a difficult, perhaps into an impossible, labor); that is, into a mento-anterior position. This flexion or extension of the head is often (in consequence of the condition of unstable equilibrium in which the head is placed) very easily accomplished, and a case of brow presentation, where the head has remained for hours immovable, as soon as restored so as to offer one of the poles of the occipito-mental diameter will terminate with the greatest rapidity. The head can be flexed or extended either by the whole hand—version by the vertex—or by a sort of bipolar version of the vertex, already described in speaking of the treatment of presentation of the side of the head. Sometimes the lever will instantly restore the head to a desirable presentation. Under no circumstances should the forceps be applied until after the head has been made to assume a proper presentation. To attempt to drag down a head with the brow in the lowest part of the blade would be criminal malpractice.

## PRESENTATIONS OF THE PELVIC POLE OF THE FŒTAL ELLIPSE—BREECH PRESENTATIONS.

In studying the causes of presentation and position we saw that a normal fœtus in a normal uterus, at the conclusion of a normal gestation—that is, a gestation during which there had been no accidental circumstance happening to mother or child sufficient to cause the child to change its attitude in the cavity of the uterus about the sixth month of gestation—would invariably present at labor by its vertex. Occa-

FIG. 261.



First Position of Breech at Superior Strait.

sionally, however, for reasons already given, the fœtus presents by its pelvic or coccygeal extremity, and this extremity of the fœtal ellipse may offer in several ways. Thus, the breech may offer in its totality —that is, with the thighs flexed on the abdomen and the legs on the thighs; or the lower extremities may offer first, either by the feet or knees; or one limb may be extended along the abdomen, while the other offers partially or completely unfolded.

Instead of considering these several presentations of the elements of a breech presentation as distinct presentations, I shall consider them all simply as breech presentations, since the modifications to which I have alluded do not in any way affect the mechanism involved, or the treatment necessary.

Statistics show that one child out of three is lost when presenting by its breech; they also show that breech presentations occur perhaps once in fifty labors. It is evident, then, that one of the chief causes of mortality to the child during labor is this comparatively common presentation, and that a correct knowledge of its mechanism and treatment is more important to the practitioner than almost any other subject in Obstetrics, save perhaps that of hemorrhage.[1]

### DIAGNOSIS OF BREECH PRESENTATIONS.

(*Cazeaux.*)

Even before the commencement of the labor, a breech presentation may be almost positively diagnosticated by the following signs—namely: in thin women, in whom the abdomen, from being previously distended by numerous pregnancies, retains a certain degree of softness and flaccidity (and the womb containing only a moderate quantity of liquid), we may more or less readily detect the head occupying the upper part of the uterus and inclined toward one or the other side. Often no part, however, can be made out by the internal exploration, since the hard rounded tumor felt in the vertex presentations is absent. Sometimes a little tumor (the foot or a knee) can be detected and balloted; and, further, the heart's movements are revealed by auscultation at an elevated point of the abdomen, on a level with, or possibly above, the umbilicus.

To the foregoing signs may be added the following as distinguishable during labor: The bag of waters is very large, and projects considerably into the upper part of the vagina, sometimes assuming the form of an elongated tumor, which may descend even to within a short distance of the vulva.

When the membranes are ruptured a very considerable quantity of water escapes, for the presenting part fills up the neck but very imperfectly, and hence all the amniotic liquid flows out; and if the rupture should occur during a strong pain, it would probably be accompanied by a loud report.

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[1] Dr. J. D. Nourse, *Ohio Medical Record*, reports a woman who had twelve confinements with twelve breech presentations. Her last was twins, one of which had a vertex presentation.

A momentary suspension or a diminution of the pains often results from a too copious or a too rapid discharge of the waters; and, further, a flow of meconium most generally takes place soon after the membranes give way.

But the only characteristic signs are those furnished by the touch, and they will vary with the presenting part.

When the breech alone presents, the finger first encounters a soft rounded tumor, upon some portion of whose anterior surface a hard, resistant part, formed by the great trochanter of the thigh-bone, is detected. Thus far, it might be mistaken for a vertex presentation, but if the finger be next carried upward and backward so as to reach, as it were, the sagittal suture, it will penetrate into the fissure between the nates, at the bottom of which the most important diagnostic signs are discovered; for the point of the coccyx is felt toward one side, surmounted by an irregular osseous surface constituted by the posterior face of the sacrum; then the anus, a small, rounded, and wrinkled orifice, into which the finger cannot be introduced without resorting to considerable force; lastly, the external genital organs can be easily distinguished, and thereby the sex of the child may be announced in advance.

The prominence of the coccyx is not only a certain sign of the presentation, but it may also serve to determine the position, because its point is always directed toward the side not corresponding with the child's back.

Where the two feet present together in the vagina, it is impossible to confound them with any other part, and the direction of the heels then clearly indicates the child's position. But when a single foot only is detected, and that very high up, it might be mistaken for a hand. However, a little attention will serve to distinguish them: thus, the toes are arranged in the same line, are shorter, and less movable, while the fingers are longer and the thumb separated from the others; the internal border of the foot is much thicker than the external, but the two margins of the hand are very nearly of the same thickness; again, the foot articulates with the leg at a right angle, while the hand continues out the line of the arm.

The diagnosis is very difficult when the feet present along with the nates and they alone are accessible. Sometimes even only one foot can be felt, which renders the case still more obscure; then we have first to ascertain which is the foot touched, though for that purpose it is only necessary to pay attention to the relation existing between its internal border and the heel. For instance, let us suppose that the latter is turned toward the symphysis pubis and its internal border to the right side of the mother; this is evidently the right foot: if, on the contrary, the heel be directed toward the sacro-vertebral angle and the internal border to the right, this would be the left foot, etc.; now, the right foot being once distinguished from the left, it only remains to determine toward what part of the superior strait the points of the toes are directed (bearing in mind that we always suppose the inferior extremities to be flexed on the abdomen and the feet crossed and turned inward). In this position of the child, if the toes of the right foot are turned toward any point of the anterior half of the pelvis, the back will be directed to some part of the left lateral half; but if the toes on the left foot point toward the anterior half of the pelvis, the child's back will look to some point on the right lateral half, and *vice versâ*.

The knees very rarely present first; besides, they have such well-marked characteristics in their form, their roundness, their hardness, the size of the limbs attached, and the fold of the ham which surmounts them—a fold presenting a transverse concavity instead of the convexity exhibited at the elbow and instep—that we consider it useless to dilate further upon the diagnosis.

*Mechanism.*—For the reasons that I have already given in discussing vertex presentations, we may take, in considering the mechanism of breech presentations, at the superior strait, six points of departure—viz. the four inclined planes, the symphysis pubis, and the promontory of the sacrum; in other words, we classify all breech presentations under six positions; three of these we designate as *sacro-anterior* positions, and three as *sacro-posterior* positions. I shall call that position the *first* where the sacrum of the child is in relation with the *left anterior* inclined plane; hence the first position of the breech is the *left sacro-anterior* position. This position is by far the most common, and the cause is evident. In consequence of the presence of the sigmoid flexure of the colon on the left side the child has more room and greater latitude of movement in this first position than in any other; hence the causes which regulate the position of the fœtus in utero—and which you now all so well understand—determine the preponderating frequency of this position. If this reasoning be correct, the very same causes should make the next most common position of the breech that where the sacrum is directed *behind* and to the *right* side of the pelvis. The statistics of all observers show that this position—viz. the *fourth*, or the *right sacro-posterior* position—*is* the next most common position. Naegele gives us statistics of 163 cases of breech presentations; of these, 120 were in the *left sacro-anterior* position, and 40 were in the *right sacro-posterior* position.

In studying the mechanism of breech presentations we may take the *first* position as the *typical* one; in this position the dorsal plane of the child is in front and to the left. Before labor comes on the child sits in the uterus, its head *moderately* flexed, its limbs flexed and in more or less complete contact with its anterior plane. When the mouth of the uterus is dilated and the bag of waters ruptures, the irregularity of the presenting part permits *all* of the liquor amnii to escape; hence the walls of the uterus come into intimate contact with the child, and thus the flexion of the head is perfected and the limbs are pressed close to the fœtal body. The *first* effect of uterine contractions, then, in the second stage of labor is *adaptation*, which in breech presentations means the complete flexing of the head and the squeezing of the limbs as closely as possible to the body.

The next change is *descent*. The breech, under the propelling powers of labor, slowly descends into the pelvic cavity, the sacrum sinking down the left anterior inclined plane; and in this *oblique* position the breech reaches the *floor* of the pelvis. I shall suppose, in my description, that the inferior extremities are extended along the child's anterior surface. Having reached the floor of the pelvis, the breech of course can advance no farther in the direction in which, up to this moment, it has been urged; a *new* force—the force of *resistance*—is now impressed upon it, and a *tendency* to *rotation*, or the *resultant* movement, is developed. A *tendency* to rotation is developed, because the conditions now are not identical with those we studied in vertex presentations; in vertex presentations the head of the child, *large* and *hard*, affords ample force of resistance to secure a *complete* rotation or resultant movement, while in breech presentations, the comparatively small diameters of the breech, with its soft and yielding structure, develop but little force of resistance; and hence, constantly, rotation of the breech *does not occur at all*, or does so *only partially*. However, I am now describing a *theoretical* case, and after this explanation will suppose that a sufficient force of resistance is furnished to secure a *complete resultant* movement: under this force of resistance, in the case before us, and in consequence of precisely the same causes that give us rotation in vertex presentations, the *anterior* hip sweeps to the front and gets beneath the symphysis pubis, while the posterior hip goes into the hollow of the sacrum. The shoulders and head, tightly grasped by the walls of the uterus, do not participate in this movement, but retain their original oblique position, and hence there is a twist in the loins of the child. The *anterior* hip now becomes fixed beneath the pubic arch, while the posterior or sacral hip—*as the only part free to move*—under the influence of the propelling forces of labor *slowly* advances, sweeping along the hollow of the sacrum and the distended perineum, and describing that arc of a circle with which you are all so familiar in vertex presentations. I say the posterior hip *slowly* advances, for though I describe the change in a few words, yet in a primipara it may take hours for the soft and yielding breech to stretch the rigid tissues of the perineum and vulva sufficiently to permit even the anterior hip to appear at the opening; and after this a long time may elapse before the posterior buttock is seen, the firm margin of the rigid perineum slipping into the fissure between the nates, and defying, sometimes for hours, the efforts of Nature to free it from its grasp. Ultimately the breech is expelled. Should the shoulders have remained oblique in the uterine cavity, the loins now untwist and a movement of restitution takes place. The shoulders now engage at the superior strait, more or less nearly in the *right oblique* diameter; the arms, in a typical case, where no traction has been made on the inferior extremities, are kept by the grasp of the uterine fibres flexed and with the elbows against the sides of the thorax. In artificial breech presentations—that is, in cases of version and in all other cases where traction has been made on the lower extremities—the body is dragged away from the arms, which in consequence become extended along the sides of the head. In a typical case, then, the shoulders and arms engage, as I have described, in the right oblique diameter; the bis-acromial diameter, four inches, being, more or less accurately, in relation with the right oblique diameter, which is five inches. In this oblique position the shoulders reach the floor of the pelvis; here, in consequence of the greater bulk of the advancing shoulders, *fortunately*, a force of resistance is met much greater than that received by the buttock; and hence the resultant movement, or rotation, takes place—not always by any means, but much more frequently and much more completely than is the case with the nates. I say, *fortunately* this rotation of the shoulders generally occurs spontaneously, since *rotation of the shoulders* in *breech presentations*—whether spontaneous or whether secured by the manipulations of the medical attendant—*is of vital importance* to the subsequent successful termination of labor. This rotation of the shoulders brings the anterior shoulder, with its flexed upper extremity, beneath the pubic arch, while the posterior shoulder and flexed extremity go to the hollow of the sacrum.

The head now offers at the superior strait, *the cavity of the uterus almost empty*, while the uterine walls in consequence *exert little or no grasping power over it;* hence the rotation of the shoulders places it more or less accurately with the face looking toward one iliac fossa and the occiput to the other; and it is for this reason that *rotation of the shoulders* is of such *vital* importance in breech presentations.

The transverse diameter of the superior strait is its longest diameter, being five and a quarter inches; the longest diameter of the child's head is the occipito-mental, five inches; *hence* when the head offers at the superior strait, with the face looking to the iliac fossa—in other words, in the transverse diameter—*even though it be completely extend-*

*ed*, it can offer *only five inches*, and therefore can *easily* and *readily* engage and descend.

When the head engages at the superior strait in a breech presentation, an ensemble of conditions is presented peculiar and entirely exceptional; *apparently*, labor is almost terminated; the body of the child as far as the umbilicus is already delivered; when, just at this seemingly auspicious moment, a peril presents itself, so grave, a danger so imminent, that the child's life may be lost in a few moments and the labor may be greatly prolonged. This peril consists, as I have just remarked, in *a combination of dangers*. In the first place, as soon as the body of the child is delivered as far as the umbilicus, the cord must necessarily be compressed, which compression is vastly increased when the more bulky and hard head engages. This compression of the cord will vary with the relative size of the head and pelvic cavity, and also with the location of the cord; it is always dangerous, but at times it is sufficient to suspend completely the fœto-placental circulation and to occasion rapid asphyxia. Again, when the head engages at the superior strait the uterine cavity becomes practically empty; this great diminution in the size of the uterus cuts off *almost entirely the flow of blood to the placenta*, and causes at the same time *the placenta to begin to separate from the uterus;* either of which conditions will rapidly asphyxiate the fœtus even if the cord be not compressed.

Here, then, are *three inevitable conditions that cannot*, in any way, be avoided, any *one* of which will cause speedy death if prolonged for only a few minutes. *Every child* born by its breech *must experience* these conditions, and hence the fatality of breech presentations when improperly treated is easily explained.

At this moment of supreme danger, when, as we have just seen, *a few seconds of delay* may make the difference of life or death to the child—at this moment, when *every* force of labor is needed to accomplish a rapid expulsion of the head, *the force*, which until now had done almost everything, suddenly is annihilated, and the child can only be rescued from inevitable destruction by the application of *new forces* and the skill and knowledge of the attendant. The force *now lost* is that of the uterus. When the head engages at the superior strait the uterine cavity is almost empty; hence its expelling power is gone—gone at the very moment when most needed. Fortunately, the pressure which the head makes on the rectum and bladder as it sinks into the pelvic cavity gives rise to considerable irritation, and causes the mother to voluntarily strain; hence the emotion and volition of labor step in to save the otherwise doomed child at the moment when the automatic and reflex uterine forces desert it. These, then, are the peculiar conditions and dangers which belong to every case of breech presentation.

Let it be supposed now, in the case under consideration, that the head is offering properly—that is, transversely—at the superior strait; urged by the straining efforts of the mother, it engages and *reaches the floor of the pelvis in this transverse position; rotation does not take place until the force of resistance is secured;* then, and not until then, the occiput is placed beneath the symphysis pubis, while the face goes into the *lower part* of the sacrum and the distended perineum; and presently, should the *vis à tergo* be sufficient, the expulsion will be accomplished.

As has been stated, the mechanism of the *first* position of breech presentations is the *type* of the mechanism of all other positions in breech presentations; and therefore little remains to be said in order to give a clear comprehension of the whole subject. The *second* position—the *right sacro-anterior* position—has a mechanism identical with the first. In the *third* position—the *sacro-pubic*—the hips and shoulders will rotate as they did in the first position, when the head will be found, in consequence, looking more or less transversely, precisely as in a first or second position. Should, however, from any cause rotation not take place, or should the case be conducted by an ignorant attendant who does not understand the mechanism of labor, and when rotation fails to take place does not secure it by proper manipulations, then the head will offer at the superior strait — not transversely, or even obliquely, but with the face looking *directly back.* The antero-posterior diameter of the superior strait is *only four inches;* a head offering with its occiput directly in front and its face looking back is *always more or less extended;* if completely extended, its occipito-mental diameter, *five inches,* offers; if partially extended, the occipito-frontal diameter, four inches, offers to the four-inch diameter of the strait, the head cannot pass, and labor is arrested. Unfortunately, however, in consequence of the conditions which we have studied, *delay,* even for a few moments, at this period of labor is *necessarily fatal* to the child; and therefore the principle is clearly established that *rotation of the hips* and *rotation of the shoulders* in breech presentations are almost essential to the *successful termination* of labor for the child.

The mechanism of the sacro-posterior positions can also be stated in a few words. Take the *fourth* position, or the *right sacro-posterior* position, as the type; here the dorsal plane of the child looks behind and to the right; the breech descends, the sacrum of the child sinking down along the right sacro-iliac synchondrosis, and *in this oblique position* it reaches the floor of the pelvis; rotation now occurs, which brings the *anterior* hip to the symphysis pubis, and *the hips and shoulders* are finally expelled, *precisely as in sacro-anterior positions.* This rotation of the hips and shoulders *necessarily* places the head *transverse* at the superior strait, and the labor terminates by the occiput getting beneath the pubic arch, just as if the case had been a primitive sacro-anterior position. Should, however, from any cause, complete rotation of the hips and shoulders not take place, the head of course will not be made to assume the transverse position at the superior strait, but will engage and descend in the oblique diameter; in most instances, even in this case, as soon as the head meets the force of resistance the occiput rotates to the pubic arch. Sometimes this anterior movement does not occur, but the occiput goes into the hollow of the sacrum, while the face gets *behind* the symphysis pubis; as the descent of the head progresses the nape of the neck rests against the anterior edge of the perineum, and the head is finally expelled, *the face* appearing beneath the arch. The *fifth* position, the *left sacro-posterior*, has a mechanism identical with the fourth. The *sixth position*, the *sacro-sacral*—like its analogue, the sacro-pubic—may have rotation of the hips and shoulders, which causes the head to assume an oblique or even a transverse position at the superior strait, and the labor terminates by the occiput going into the hollow of the sacrum, or at times even coming beneath the arch. In certain rare cases rotation might not happen; then the head would offer at the superior strait more or less extended and with the face directly in front; of course it could not pass in this position, and labor would be impossible; at last, however, delivery might be secured by the following mechanism: The chin might be forced well over the top of the symphysis pubis, and the anterior part of the child's neck be pressed closely against the inner surface of the symphysis; if, now, the expelling effort were very strong, the occiput—as the only part of the head free to move—might descend into the pelvic cavity along the hollow of the sacrum, and finally the head might be expelled, the *anterior* part of the neck getting under the arch of the pubis and the occiput appearing *first* at the vulva. Such a mechanism, implying as it does a greatly prolonged labor, would necessarily be fatal to the child.

We come now to the all-important subject of the treatment of breech presentations. It is evident, after the description given, that the earlier parts of a labor by the breech are tedious—that the danger to the child does not begin until its body is born as far as the umbilicus and the head engages at the superior strait; it is also evident that, though the *earlier* parts of labor may last for many hours without detriment to mother or child, the *final part*—that is, the delivery of the head—*after it begins to engage at the superior strait* cannot be *prolonged many minutes without necessarily* causing the death of the child. It is clear, too, that at this supreme moment, when the child's fate hangs in the balance and a very rapid termination of labor *alone* can save it—that at this supreme moment the *chief force* of labor *up to this time* is suddenly annihilated, and unless a *new force* or forces be applied, either by Nature or by the attendant, the child cannot be saved.

From these considerations, then, the following conclusions may be drawn: In breech presentations the *first* stage of labor should be *thor-*

*oughly* accomplished before the second stage begins. Hence *never* rupture the bag of waters, knowing how very valuable it is in dilating, safely and thoroughly, the external organs; the woman should be kept quiet, so that no movement on her part may cause a premature rupture of this important dilator.

During the second stage of labor there should be made no attempt to hasten the delivery of the breech; it may be hours, especially in a primipara, before the soft and yielding nates overcome the resistance of a rigid perineum; yet this delay is not dangerous, while it secures a *complete stretching* of the structures, through which, at the close, we wish to bring the head with great rapidity. In this part of labor, then, the only precaution necessary is to favor or cause *rotation of the hips.*

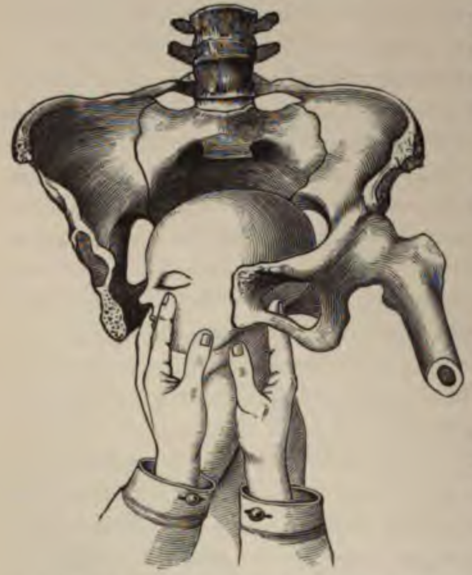
At last the breech is born; the lower extremities, if not before, are now extended and delivered; these in a *natural labor* should be merely supported, and the delivery trusted to Nature until the body is expelled as far as the umbilicus. The cord should now be pulled a little down, so that it may not be too much stretched, or if it be between the nates it should be freed and brought opposite one of the sacro-iliac symphyses.

About this time the uterine force is rapidly failing and *new forces* must be applied. One of these *new* and *indispensable* forces is the voluntary bearing-down efforts of the mother. The woman should be directed to use her utmost effort; the emotion of labor should be stimulated by assuring her that the safety of her child in great measure depends now upon herself. Under this *new* force the shoulders rapidly descend, the arms in a typically natural case flexed and the elbows in contact with the sides of the thorax; should, however, one or both arms become extended, they must be brought down in the way described in the treatment of *artificial* breech presentations, or version. As soon as the shoulders have reached the floor of the pelvis *prompt* and *complete* rotation must be secured by forcing the posterior shoulder into the hollow of the sacrum; this movement places the head *transverse* at the superior strait; in which position, even if it be *completely extended,* there will be ample room to permit rapid descent and delivery. Here the supreme moment of labor is reached; the process may have lasted *safely* up to this time for many hours, but now a *few minutes of delay* are fatal. The question, then, is how to secure the quickest delivery. The uterine power is lost; traction on the body of the child not only extends the head, but may *damage the spinal cord beyond the possibility of recovery;* a *vis à tergo* is required rather than *any force from the front,* and we supply this *vis à tergo* by directing the mother to *strain to her utmost;* supporting the body of the child, two fingers should be insinuated along the *side of the pelvis*—the head, recollect, is *transverse*—and placed at the root of the nose, or, if this cannot be done, in the mouth; the fingers of the other hand should be placed supportingly on the *back* of the head. In much less time than has been occupied in giving these directions the head descends into the pelvic cavity; *when it has reached the floor of the pelvis,* and *not until then,* the rotation of the occiput to the symphysis pubis should be secured, and in a few seconds, the mother continuing her straining efforts, the child will be expelled.

All works on Obstetrics show the head *rotated, with the face in the hollow of the sacrum, before* it has reached the floor of the cavity; assistance is represented as rendered by the fingers *inserted along the perineum.* The posterior depth of the pelvic cavity is five inches for the bony pelvis, and four or five inches for the distended perineum—in all, say *nine or ten inches;* hence it is evident that when the face is *where the books represent it to be*—viz. in the hollow of the sacrum—your fingers will scarcely reach beyond the coccyx, and you *will not be able* in ordinary cases to apply them *as represented on* the sides of the face.

The accompanying drawing will illustrate a very important principle in the proper management, not only of breech presentations, but also of version.

FIG. 262.



Breech Presentation: head transverse in pelvis.

The head is represented as *transverse* in the pelvis; the lateral depth of the pelvis is three and a half inches; *hence when the head is transverse,* the fingers, inserted on the *side of the pelvis, can easily reach to the superior strait,* and can easily be applied to the root of the nose, or in the mouth, as shown in the drawing, and the head can *quickly* and readily be *conducted—still in the transverse diameter*—to the floor of the pelvis.

We constantly meet with cases where the mother cannot supply the necessary expelling power, or does so inefficiently, at the moment when the child is doomed to certain destruction unless delivered rapidly. Here the almost universal practice is to apply the forceps. An obstetrical writer and teacher can scarcely be found who does not direct in cases of breech presentation to have the forceps ready, and, when the moment of great peril comes, to apply it. Now I wish to be understood as stating absolutely and positively *that the forceps is seldom or never required* in the delivery of the head in breech presentations. The use of this instrument, so universally recommended, is a *rough, unintelligent* application of *unnecessary* and *badly-applied force.* A thorough knowledge of the mechanism and physiology of breech presentations reveals forces amply sufficient to accomplish the much-to-be-desired speedy delivery of the head; in other words, *the power* in such cases should reside in the well-instructed brain of the intelligent practitioner, and not be sought for in the rude grasp of his iron instrument.

When treating a case of breech presentation where the head has reached the superior strait, and the mother cannot supply the necessary expelling power, *do not think of the forceps, but apply the hand or hands on the lower part of the abdomen*, or an assistant can make the pressure needed, and *press directly down on the head;* it is easy by this proceeding to *apply any amount of vis à tergo*, and to *supplement entirely* the lost force of the uterus and the lost force of the mother's efforts. Never forget that in almost all cases of breech presentations the forceps is unnecessary, and that the rapid delivery of the head can always be *easily* and *quickly* secured *by the bearing-down efforts of the mother*, aided, or even *replaced, by the bearing-down efforts of the attendant.*

### DEVIATED BREECH PRESENTATIONS.

In certain cases of uterine obliquity the breech offers obliquely at the superior strait. It may be a hip or the sacrum or the posterior part of the flexed thighs. In all such cases the part thus offering obliquely cannot engage, and it becomes necessary to bring the breech fairly to the superior strait.

The hand must be introduced, and the presentation must be properly modified: in accomplishing this it might be necessary to bring the lower extremities down into the pelvis (as in version by the feet). Should this be done, the case will not be complicated at all, but requires only the usual treatment for breech presentations.

## PRESENTATIONS OF THE TRUNK.

Trunk presentations are not very common; they occur about as frequently as face presentations, perhaps about once in 250 cases. The causes of trunk presentations are discussed in our remarks on the natural causes of presentation and position. These causes are uterine obliquities; twin labors, the second child frequently offering by the trunk; placenta prævia; small size of child; large amount of liquor amnii; abnormally-shaped uterine cavity; deformities at the brim of the pelvis, etc. etc.

### DIAGNOSIS OF TRUNK PRESENTATIONS.

(*Cazeaux.*)

There is sometimes reason to suspect a trunk presentation even before the commencement of labor from the following signs: The abdomen is much larger in its transverse diameter than usual, and when its walls are soft and flabby they can often be depressed enough to detect the fœtal head in one of the iliac fossæ, presenting there as a hard, rounded, and resistant tumor; then by placing the hands opposite each other in the lumbar regions a greater and firmer resistance, offered by the two extremities of the fœtal ovoid, will be felt at these points, and the solid body formed by the child may be readily moved from side to side, thus proving that its long axis lies transversely above the superior strait. Finally, the tumor formed by the head in the vertex presentations is no longer detected by the vaginal touch, and it is almost impossible to reach the presenting part. In some rare instances the elbow or the hand of the child may be recognized and balloted; and this sign, accompanied by the first two, renders the diagnosis quite probable.

The form of the abdomen is then very irregular, especially if the uterus should contain but a small quantity of amniotic fluid. It has, however, been observed that after the discharge of the waters the longitudinal diameter gradually becomes greater than the other, because the transverse position has no longer a real existence, for the body of the fœtus is so curved upon itself that one of its extremities is lodged in the fundus of the uterus, although the other does not correspond to its orifice.

We do not believe that auscultation is capable of throwing any light upon the diagnosis. Sometimes, however, it may prove a useful auxiliary. If, for example, a small member of the fœtus be detected by the touch, and the pulsations of the heart are heard in the hypogastric region, we may conclude almost certainly that the member belongs to the upper extremity. Should the heart be heard on a level with the umbilicus, it would most probably prove a pelvic extremity.

Before the membranes are ruptured, the elevation of the part renders the vaginal touch very difficult; and so, of course, the form of the bag of waters or that of the uterine orifice can be of but little service. It is said the os uteri dilates more slowly, but as this slowness of dilatation is met with in all presentations excepting those of the vertex, it forms a sign of minor importance. The touch, therefore, can only give a positive certainty after the rupture of the membranes. When the side is the presenting part, the shoulder is very frequently found at the centre of the superior strait, as also the elbow or the side of the chest.

and hence will be the first encountered by the finger in making an examination; and we therefore have to point out the characters successively whereby these several parts may be recognized.

When the shoulder presents, the finger first detects the rounded tumor formed by its summit, upon the surface of which a small osseous projection, constituted by the acromion, is distinguished; then, behind or in front, according to the position, the clavicle and the spine of the scapula are felt, and below the scapula there is only a plane surface, terminated by the acute inferior angle of this bone, which is movable and permits the finger to slip under it; lastly, on the sides of the tumor formed by the shoulder the axillary space can always be distinguished, and sometimes also (though on the opposite side) the depression in the neck can be felt.

The shoulder being once recognized, we must next determine which one it is and what is its position. I will remark, in advance, that we have admitted but four positions of the trunk—namely, two for the right shoulder and two for the left—and that the relation existing between the situation of the head and that of the child's posterior plane is different in each of these four. Thus there are two positions where the head is to the left—namely, the first position of the right and the first of the left shoulder—and remark that in the latter the child's back is turned toward the mother's loins; in the former, on the contrary, it is in front; and therefore whenever the head is to the left and the child's back is behind we have to treat with a first position of the left shoulder.

In the same way there are two positions in which the head is to the right—to wit, the second of the right and the second of the left shoulder; but again observe that in the latter the back looks forward, while in the former, on the contrary, it is directed posteriorly. Hence to recognize a second position of the left shoulder it will only be necessary to ascertain that the child's head is turned toward the mother's right side, and that its back looks anteriorly. In a word, to satisfy ourselves which is the presenting shoulder, and what is its position, we only have to find out where the head lies and the position of the posterior plane of the child.

The shoulders presenting and being recognized, it is evident that if the axillary space looks toward the mother's right the head will be to her left, and *vice versâ;* consequently the situation of the head is readily known by the direction of this space, and, as regards the child's dorsal plane, the omoplate will clearly indicate its position.

When the elbow alone is accessible to the finger, it may be recognized by the three osseous projections (the olecranon and the two condyles) which it presents, by the transverse convexity in the bend of the elbow, and by the vicinity of the chest and intercostal spaces. The elbow having been distinguished, it will be necessary to make out the position to ascertain where the fœtal head and its dorsal plane lie; but this is now comparatively easy, since the elbow is always directed toward the side opposite to that where the head is found, and the forearm is always placed on the anterior plane.

Again, as above stated, it happens at times that the forearm is not doubled up, but that, on the contrary, the hand hangs down in the vagina or even appears at the vulva. Now, to determine which is the presenting hand in those cases it is necessary to turn it in such a way as to place its palmar surface in front and above; for in this position if the thumb be directed to the mother's right thigh it is the right hand, but if to the left thigh it is the left hand; and then, to find out where the head is, the accoucheur must slip his finger up to the axillary space.

When the hand comes out at the vulva a careful inspection of it will most generally be sufficient to establish the diagnosis. Thus, if its dorsal surface is turned toward the patient's right thigh, the head is at the right, and if to the left thigh, the head is at the left. The little finger directed toward the coccyx indicates that the child's dorsal plane corresponds to the mother's loins, and the same finger pointing to the pubis is an evidence of this plane being in front.

We have been thus particular in the diagnosis because it is all-important in trunk presentations to understand clearly which side presents at the strait, since the accoucheur must always endeavor to turn; and if the details just given prove difficult of comprehension from a simple reading, we hope they will become clearer by practising on a manikin.

### MECHANISM OF TRUNK PRESENTATIONS.

In a trunk presentation the child may offer any part of the trunk, but for the purposes of description and treatment all trunk presentations may be classified into two positions—viz. presentations of the right and left sides. When the head of the fœtus is turned to the left side the position is called the first position of the presenting shoulder, the left cephalo-iliac position. When the head is directed to the right side, we term the position the second position of the presenting shoulder—the right cephalo-iliac position.

Before entering on any discussion of a possible mechanism of labor in trunk presentations, it will be proper to state that, as far as treatment is concerned, a trunk presentation has no mechanism; that is, that a trunk presentation is always, practically, to be looked upon as an impossible case of labor—is never to be trusted to Nature—is always promptly to be assisted. After this positive statement it may not be amiss—rather as a matter of scientific curiosity than for any sure guide to treatment—to describe how Nature sometimes terminates these cases spontaneously.

There are two mechanisms by which a trunk presentation may terminate. One of these is called spontaneous version, the other spontaneous evolution.

First, of spontaneous version. By spontaneous version is meant a spontaneous change in the presentation of the child, in consequence of which the fœtal ellipse revolves in the cavity of the uterus in such a manner as ultimately to cause one or the other pole of its long axis to offer at the superior strait, when the case may terminate without difficulty. Spontaneous version is more possible before the rupture of the bag of waters than after. At this period, though labor has actually commenced, the fœtus sometimes exhibits great latitude of motion in the amniotic cavity, and in consequence may change its position; and in this way the child has been recognized as offering many parts of its surface before the presentation became fixed, after the escape of the liquor amnii.

But even after the escape of the liquor amnii, in some rare cases, this movement has taken place. Perhaps the most satisfactory explanation of the cause of spontaneous version after the escape of the liquor amnii, when the child is tightly grasped by the walls of the contracted uterus, is the theory that it is generally owing to irregular and partial contractions of the uterus (Cazeaux).

We may suppose a case of trunk presentation where many hours have passed in useless effort; finally, the uterus becomes worn out and exhausted, and falls into the condition of irregular contraction, as it is termed. That is, only a part of the organ contracts, while the rest remains absolutely paralyzed and incapable of offering any resistance. We may suppose that one side of the organ contracts and the other half is inert. The contracting side acts on one pole of the fœtal ellipse and pushes it down toward the cavity of the pelvis, while at the same time the paralyzed side offers no resistance to the ascent of the opposite pole to the fundus. Should this condition last long enough, the fœtus would eventually become completely turned in the cavity of the uterus; one of its poles would offer at the superior strait, and labor might terminate spontaneously.

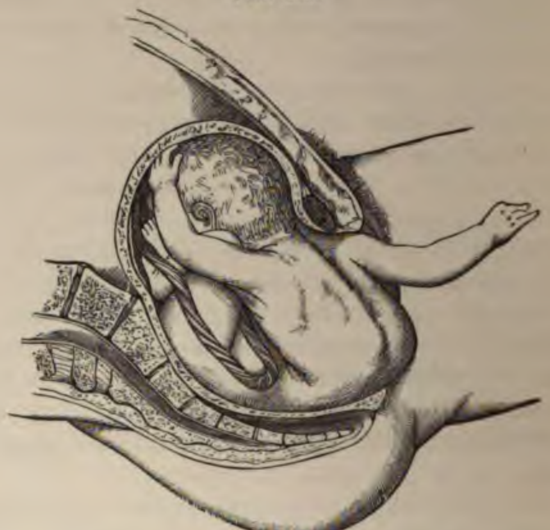
The second mode by which a trunk presentation may terminate spontaneously is called spontaneous evolution. Spontaneous evolution is a regular mechanism by which, in very rare and exceptional cases, a trunk presentation is delivered, not by a change of presentation, as in spontaneous version, but delivered as a trunk presentation.

We may take as our illustrating example the first position of the right shoulder, the left cephalo-iliac position.

As soon as the bag of waters ruptures, as the presenting side does not stop up the mouth of the uterus, all the liquor amnii escapes; the uterus contracts strongly, and the child is bent in the direction of its long axis toward the side opposite the presenting one. In other words, Nature makes an unsuccessful attempt to cause the presenting side to offer by the smallest diameters possible in order to secure its engagement and descent. Hence in a trunk presentation, as in all other presentations that we have studied, the first effect of uterine contractions after the waters escape is to adapt (in this case to try to adapt) the presenting part to the diameters of the superior strait.

The long axis of the fœtal ellipse, however, even when bent as much as is possible, cannot pass any of the diameters of the pelvis. The next effect of the propelling forces is to push the presenting shoulder into the cavity. The shoulder now descends—how far? Only as far as the length of the side of the child's neck will allow; that is, for about an inch and a half; a further descent would imply that the child's neck was of abnormal length—the neck of a human giraffe—or a simultaneous engagement of the head and trunk, which is impossible. The shoulder, now coming in contact with some part of the anterior inclined plane, especially if the arm should be down and in the vagina, *may* meet sufficient force of resistance to impress upon it a resultant movement, and rotation of the shoulder might take place. This rotation of the shoulder would bring the presenting shoulder to the arch of the pubis, the head moving to the front and getting over

FIG. 263.

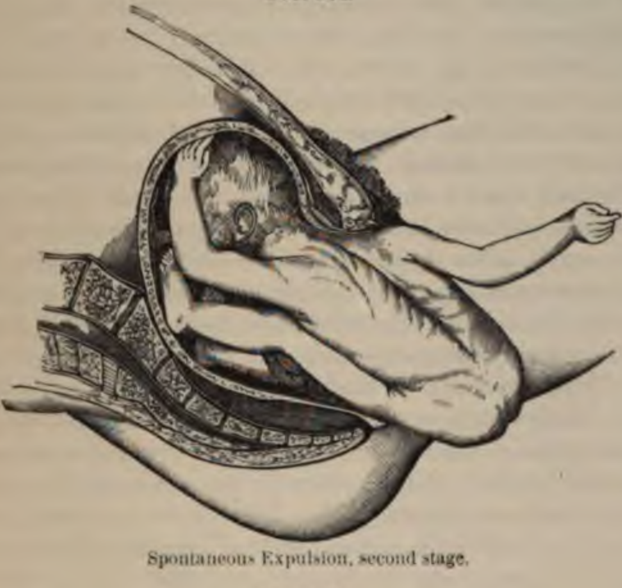


Spontaneous Expulsion, first stage.

the horizontal branch of the pubis, and the breech placing itself over the opposite sacro-iliac symphysis.

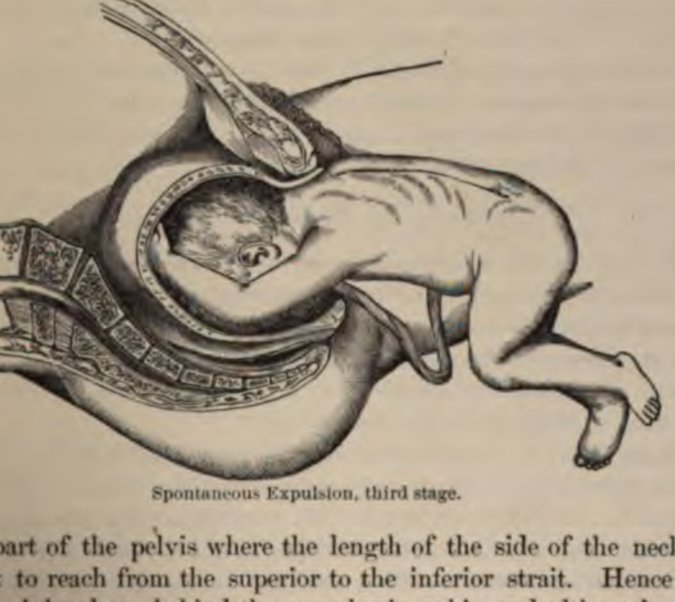
This rotation of the shoulder to the symphysis pubis has brought it to that part of the pelvis where the length of the side of the neck is sufficient to reach from the superior to the inferior strait. Hence the shoulder sinks down behind the symphysis pubis, and ultimately gets

Fig. 264.



Spontaneous Expulsion, second stage.

Fig. 265.



Spontaneous Expulsion, third stage.

beneath the arch of the pubis, the forearm and arm appearing at the vulva and the side of the neck being pressed strongly against the inner surface of the symphysis. The shoulder now is arrested, and can advance no farther; finally, the trunk is forced, doubled up, into the cavity of the pelvis. The acromion remaining fixed under the symphysis, the breech, as the only part of the body free to move, is forced along the hollow of the sacrum and the hollow of the distended soft parts, and at last the doubled-up body is expelled, the breech describing around the shoulder, resting on the subpubic ligament, an arc of a circle the radius of which is measured from the top of the shoulder to the coccyx, and which is about five or five and a half inches in a fœtus of normal size and much compressed. As soon as the body is expelled the head engages and is delivered as in a breech presentation.

The circumstances favoring spontaneous evolution are very evident: smallness of the fœtus; large pelvis, and the maternal soft parts offering the minimum resistance; and, finally, the maximum expelling powers. Spontaneous evolution, though occurring under the most favorable conditions, is yet most undesirable and disastrous to both mother and child. The mother is exposed to all the dangers of a very long and painful labor, during which all the parturient tissues are subjected to a continued pressure. She may, therefore, speedily die after such a labor, or experience injuries from subsequent inflammation and sloughing that may make death itself preferable. The child also is exposed not only to all the dangers of long and continued pressure, but to all the dangers we have recognized as attending a delay in the delivery of the head in breech presentations.

Velpeau gives statistics of 137 cases of spontaneous evolution. 125 of these children were stillborn, and of the remaining 12 children alive at birth, all, or almost all, must have died very shortly after in consequence of the injuries received during labor.

## TREATMENT OF TRUNK PRESENTATIONS.

In view of the danger of trunk presentations it has been recommended, when the presentation is recognized during the latter days of gestation and before labor comes on, to attempt by external manipulation to change the presentation to either pole of the long axis of the fœtus. The practice, however, for many reasons easily evident, is not endorsed by the best authorities.

When labor has actually begun, bearing in mind that Nature brings about spontaneous version, especially before the escape of the liquor amnii, we may try to imitate her by resorting to abdominal palpation. We may try, by acting on the two poles of the fœtal ellipse through the abdominal walls, to cause one pole to descend and the other to move to the fundus, or we may resort to bipolar version by using one hand, acting on the shoulder in the vagina, the other hand externally. Should our manipulations be successful, it will be desirable to rupture the bag of waters in order to cause the polar presentation to become fixed, since, if this precaution be neglected, the child will most probably resume its former presentation of the shoulder.

When, however, we see our patient after the escape of the liquor amnii, the indication is to perform version by the feet so soon as the mouth of the uterus is sufficiently dilated to permit of the necessary manipulations. Fortunately, the position of the child — on its side, with, most probably, its lower extremities more or less flexed on the abdomen—brings them near to or actually at the os. Hence, in most cases of version by the feet in trunk presentations, the introduction of one or two fingers into the uterus is all that is necessary to enable the operator to secure a foot or a knee, which is to be merely dragged into the vagina. The introduction of the whole hand is seldom necessary; but when it cannot be avoided, the manœuvre is to introduce the hand, seize a lower extremity, and simply drag it into the vagina, and then terminate the case as any case of version by the feet should be managed when the welfare of both mother and child must be consulted.

Sometimes, however, the shoulder is so jammed down into the superior strait, and the walls of the uterus are so firmly contracted on the child, that the introduction of the hand into the cavity of the uterus becomes an impossibility, or so dangerous that it must not be even thought of. Under these circumstances—and they are not at all uncommon, especially in a consultation practice; that is, a practice called to assist in cases that have been improperly treated, or "trusted to Nature" for a long period—the best proceeding is that recommended by Professor Wright of Cincinnati, in which he advocated bipolar version, in these previously unmanageable cases, long before this method of version was known or practised. Shortly after Dr. Wright had published an account of his method, giving at the same time several illustrative cases, I met with a case which so happily shows the difficulties where version by the feet is impossible, and at the same time the incomparable value of the Wright method over all others, that I think I cannot do better than to report it entirely, inasmuch as in such instances, when version becomes impossible, nothing remains but embryotomy.[1]

The following is a history of the case which I take from my notes:

On the evening of the 3d of April I was called by a midwife to see Mrs. M—— as a case of difficult labor which she could not manage. On reaching the patient I learned that she had been taken in labor some time in the morning, that at two o'clock she had given birth to a child, and that the midwife, on making an examination, discovered a second child presenting by the shoulder, its arm being in the vagina.

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[1] Reported in *Medical Examiner*, July, 1855.

This was at two o'clock in the afternoon. I did not see the patient until about seven o'clock, five hours after the rupture of the membranes. I then found her with the uterus contracted spasmodically upon the child, suffering a great deal of pain in consequence, whilst her condition had not been at all improved by brandy freely given by the midwife.

On making an examination I found the arm in the vagina considerably swollen, the shoulder at the superior strait, the head high up in the right iliac fossa, being readily felt through the abdominal walls, the back of the child toward the symphysis pubis. Having carefully diagnosed the position of the child, I determined to resort to version by the *feet*, but met with so much difficulty from the firm contraction of the uterus, together with the great irritability and restlessness of the patient, who rolled and struggled violently when I attempted the operation, partly no doubt from the effects of the brandy she had taken, that I was forced to desist. I then determined to try the plan of treatment as suggested by Dr. Wright, which consisted, as the first step, in carefully returning the arm into the cavity of the uterus—which was not very difficult—and then with two fingers on the shoulder I endeavored not so much to push it up as to slide it away from the superior strait, attempting, in fact, to imitate spontaneous version by causing the whole body of the child to revolve in the cavity of the uterus; this action upon the shoulder was very much facilitated by an external manipulation, through the abdominal walls, upon the head in the iliac fossa, which consisted in attempting to force it toward the superior strait. To my surprise, the shoulder readily yielded and ascended; the next minute, still continuing the process, the neck, and shortly after the side of the head, were felt at the superior strait, and then by a little more manipulation the vertex was brought down in the left occipito-anterior position. The moment the head was placed in the proper position the patient expressed herself completely relieved from the severe pain she had been suffering for hours.

For a time the uterus ceased entirely to act, but pains coming on, they were stimulated by ergot, the parts having been dilated by the passage of the first child, and in about an hour after the child was born ALIVE.

It is proper, however, to state, as explaining, to a certain extent, the facility with which the operation was performed, that the child weighed only five pounds, yet, on the other hand, it should be recollected that the smallness and mobility of the child is perhaps the most common cause of shoulder presentations; and hence in such presentations we may expect, very generally, to have small children to deal with, and moreover that version by the *feet* had been attempted and had not been accomplished.

It might be urged that as the child was not large, the case might have been left to Nature and labor terminated by spontaneous evolution. But what are the facts of the case? Five hours had elapsed since the rupture of the membranes, and one of the earliest changes noticed when spontaneous evolution takes place had not yet occurred: I refer to the rotation of the presenting shoulder to the symphysis pubis as preparatory to its engagement beneath the arch; indeed, the spontaneous expulsion of the child in these cases is the exception, not the rule; and when it does happen, if we think for a moment on the mechanism of labor by which delivery is accomplished, we cannot fail to perceive that the mother must be exposed to all the dangers attending a long and painful labor, while the child is so powerfully compressed that death is the general result.

It is asserted by some that an error of diagnosis has existed in those cases where it is stated that version by the vertex has been successfully performed in shoulder presentations—that they have been really cases of head presentation complicated by a descent of the arm. But this certainly was not so in the case to which I refer, the head being distinctly felt in the right iliac fossa through the abdominal walls, whilst the partial introduction of the hand into the cavity of the uterus in the attempt to make version by the feet enabled me perfectly to recognize the position of the child.

Again, it is said that the operation of version by the vertex is a very difficult one; that we cannot, without subjecting the mother to very great danger, push up the presenting part of the child and search for the head; and then, having found it, that we cannot grasp the round and slippery occiput and bring it to the superior strait. This objection in many cases may be well founded, but the operation which I have related consisted rather in pushing the shoulder away from the superior strait, causing thereby the child to revolve in the cavity of the uterus; of course as soon as such a motion of rotation is communicated to it by pushing away the shoulder, we must of necessity have some other part brought to the superior strait, which part will be first the neck, then the head, and by a little manipulation the occiput can be brought down, and an *impracticable* case of labor can be thus changed without, or with comparatively little, pain to the patient, and in a few minutes, to one of the most simple character; and not only thus changed, but effected without exposing the child to the great risks to which it is always liable when version by the feet is resorted to; and if an attempt to make version by the vertex should fail, without giving our patient any more pain, our hand being in the vagina, our fingers in the mouth of the uterus, we can most easily, if the case admit of it, pass our hand upward, grasp the feet, and bring them down.

Finally, should all our efforts to secure delivery by version by the feet or by version by the vertex prove unavailing, we must not desist from our attempts to terminate the case. The history of spontaneous evolution and its necessarily fatal results to the child shows that we must now only regard the welfare of the mother; and this demands prompt performance of embryotomy.

Embryotomy in these cases usually is not difficult. Under no circumstances should the arm in the vagina be (as has been done) amputated as a preliminary proceeding. Such method merely deprives the operator of a most valuable tractor after the head is amputated, and does not facilitate in any way the operation. A blunt hook is now to be used to drag the neck well down into the pelvis. The head is then to be separated from the body. For this purpose nothing is better than Ramsbotham's decapitator (a blunt hook with a cutting concave edge). Usually, however, the country practitioner will not have access to this instrument, and some other will have to be thought of. I know of nothing more efficient, and less likely to injure the mother, than an improvised écraseur consisting of a piece of stout and rather rough cord. This cord is to be gotten over the neck, and then by a little dragging and sawing movement the cord speedily cuts its way through. As soon as the head is separated, the body is to be delivered, and finally the head. This latter can generally be easily removed by carrying out the principles of treatment laid down for the management of the delivery of the head in breech presentations.

## THE MECHANISM OF THE THIRD STAGE OF LABOR.

By the Editor.

In sharp contrast to our definite knowledge of the mechanical laws that govern the expulsion of the fœtus stands our uncertainty in regard to the method by which the placenta is separated from the uterus and is expelled through the birth-canal. "If" says Berry Hart,[1] "the delivery of the placenta depended on obstetricians knowing how it separated, no woman in labor would complete her third stage;" but, unfortunately, this author adds to the confusion surrounding the subject by advancing a theory in explanation of the separation that is, to the writer's mind, quite untenable.[2]

The third stage of labor may be divided into two acts: (1) the separation of the placenta from the uterine wall; and (2) its expulsion from the uterine cavity. These two processes are most conveniently considered separately.

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[1] *Edinburgh Medical Journal*, 1887.

[2] Dr. Hart claims that "the placenta separates, not from diminution of the placental site, but during the expansion in area of the site after retraction." A glance at Fig. 266 will show the fallacy of this assertion.

*The Separation of the Placenta.*—It is usually asserted that the placenta is separated from the uterine wall by a diminution in the area of the placental site, but without further qualification of this statement it should follow that with every uterine contraction during labor, and especially in the last stages, when the child's body is partly without the uterine cavity, the placenta must be more or less forced away from the uterine wall; whereas, actually, the placenta is not separated at once, even when the fœtus has entirely vacated the uterine cavity and the uterus has been very much reduced in size. To explain the adhesion of the placenta to the uterus in spite of uterine contractions during and immediately after labor, it is only necessary to recall the peculiarities of the placental structure, resembling nothing so much as a sponge, with the branching villi separated by intervening blood-spaces. The spongy placental mass can follow the retraction of the uterine wall until the solid villi are brought into actual contact with one another and the whole placenta forms a perfectly solid mass; as soon as that point is reached, the slightest additional contraction of the uterine muscle, with the smallest decrease in the area of the placental site, springs off instantly the entire placental mass, which can no longer be compressed.

This, the writer conceives, is the mechanism of the separation of the placenta in a strictly normal case, and no other cause need be operative to effect the detachment of the placenta from the uterus. The extent to which the placenta can follow the retraction of the uterus has been shown by Barbour,[1] who found a diminution of placental area to about one-half its normal extent (4 inches by 4½ inches) before the placenta became detached from the uterine wall. This strictly normal mechanism is, however, capable of considerable variation in the individual case. The detachment of the placenta as a whole may not occur instantaneously, but not infrequently the central portion separates first, and as the periphery of the placenta is brought nearer to the centre of the placental site, the placenta bulges out into the uterine cavity, leaving a vacant space behind itself which immediately becomes filled with blood.[2] To this retro-placental effusion of blood some would attribute the separation of the placenta, but it is evidently an effect and not a cause, for it is not constant, and the amount of blood is rarely sufficient to push the placenta off from the uterus, even were it conceivable that the blood is forced out of the vessels with such violence as to remove an obstruction weighing a pound or more. Occasionally, one part of the uterine muscle seems to contract with more vigor than another, or else one portion of the placenta adheres more closely than another. At all events, the condition shown in Fig. 266 is the result—a separa-

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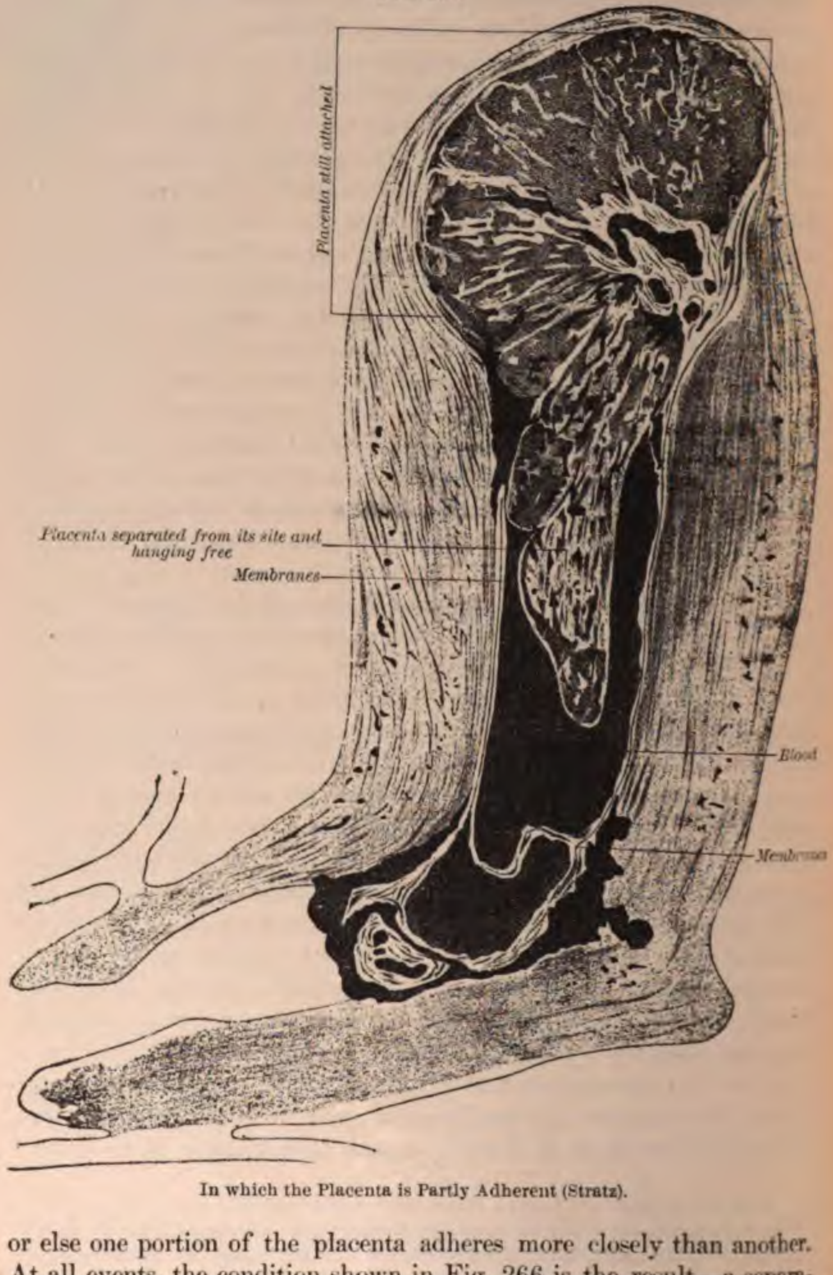
[1] "Sectional Anatomy of Labor," *Edinb. Med. Journ.*, Oct. and Nov., 1887.

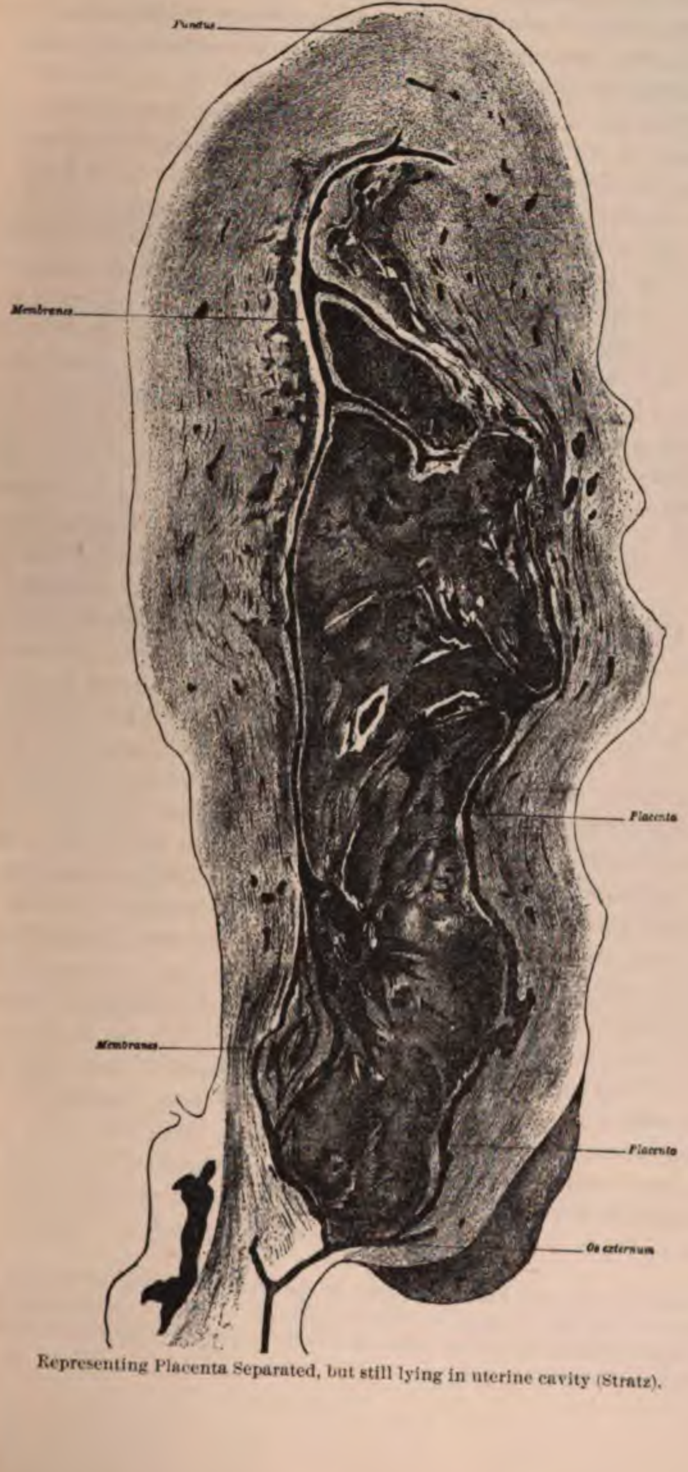
[2] See the observations made by Stratz and Barbour, who introduced their hands into the uterine cavity immediately after the expulsion of the fœtus: *Die Nachgeburtsperiode; der Schwangere u. kreissende Uterus;* and *Edinb. Med. Journ.*, Oct., 1887.

Fig. 266.



In which the Placenta is Partly Adherent (Stratz).

FIG. 267.



Representing Placenta Separated, but still lying in uterine cavity (Stratz).

tion of the whole placenta not simultaneously, but after two or more contractions, each of which forces away a greater or less area.

It must often happen that the same uterine contraction which at first so diminishes the area of the placental site as to force off the placenta from the uterine wall is, immediately after the separation of the placenta, at once converted into the detruding force that expels the latter from the uterine cavity. In such cases it would be difficult to detect the dividing moment between separation and detrusion, one seeming to be but a continuation of the other; and it is this circumstance doubtless that has led some observers to advance the theory that the placenta is separated not only by the diminution of the placental site, but also by being grasped and pushed off from the uterine wall by the action of the uterine muscle. This latter action, however, need not be called upon to explain the separation in a strictly normal case. That the detruding action of the uterine muscle may in some instances play a subordinate rôle in the separation of the placenta cannot be absolutely denied, but that in all cases the uterine walls grasp the placenta and push it off from its attachment, the writer, having in several instances introduced his hand into the uterine cavity before the separation of the placenta to investigate this point, cannot believe.

THE EXPULSION OF THE PLACENTA.—The placenta, being detached from the uterine wall, is either immediately expelled from the uterus, or else, resting a while quite detached within the uterine cavity, as shown in Fig. 267, is ultimately cast out by the uterine muscle into the cervical canal and upper portion of the vagina. Although the placenta separated from its attachment and acting as a foreign body is soon expelled from the uterus, rarely remaining unattached more than fifteen or twenty minutes, it may rest a very long time in the upper portion of the vagina and in the cervical canal without exciting the benumbed and almost paralyzed muscles of these regions to action. It is on this account that, in the civilized female at least, one cannot always trust to nature to end the third stage of labor, as was once recommended by William Hunter and his school, for as long as the placenta is retained there is some danger of hemorrhage, and it is possible for the expulsion to be so long delayed that the succulent placental mass undergoes decomposition and becomes a sure source of septic infection.[1] The placenta leaves the uterine cavity and emerges from the vulva in one of two ways—either edgewise, or else after inversion of the ovum with the fœtal side foremost. As to which of these two methods is the normal one, there is considerable difference of opinion. Baudelocque,

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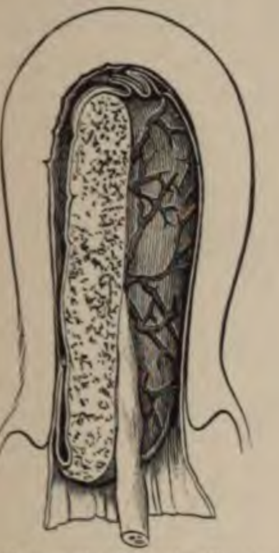
[1] While the writer was volunteer interne in the lying-in hospital of Munich it was customary in one delivery-ward to allow the placenta to remain undisturbed for two hours, and in another for twelve hours: in a large proportion of these cases expression was finally necessary.

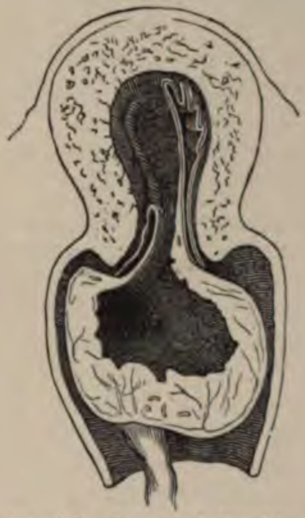
Schultze, Stratz, Tarnier, and others claim that the placenta, being heavy, sinks down to the cervix, pulling the membranes after it, and usually appears like an "inverted umbrella;" and my own observation leads me to take this view. It is admitted by all that if the placenta is attached to the fundus uteri, the ovum is more likely to be inverted, and the same result may be produced by traction upon the cord. Matthews Duncan, Barbour, and others assert that the placenta is most frequently extruded edgewise, the membranes covering the fœtal aspect. Duncan goes so far as to maintain that inversion of the ovum is the result of manual interference.

FIG. 268.



Placenta emerging Edgewise (Duncan).

FIG. 269.



Inversion of the Ovum and Expulsion of the Placenta as an Inverted Umbrella (Schultze).

NOTE.—For the Anatomy of the Gravid Uterus, and the Mechanism of the Closure of the Blood-vessels after Delivery, see pp. 327, 328.

# ON THE USE OF ANÆSTHETICS IN LABOR.

By J. C. REEVE, M. D.,

DAYTON, OHIO.

> "The teachings of etherization, then, come from experience. . . . . And he who has studied these in their diverse phases the most faithfully is he who will most safely, because most wisely, employ it."—CHANNING.

HISTORICAL.—The history of surgical anæsthesia is well known. All through the ages there had been attempts to relieve the pain of surgical operations. Then came suggestion, under the light of advancing chemistry, that was followed by the efforts of some, the achievements of others, until in October, 1846, a state of unconsciousness to pain was produced so effectually, and by an agent so reliable, that from that date artificial anæsthesia entered upon a scientific existence. The passage from this to obstetrical anæsthesia could be but a step. There had been in midwifery the same preceding effort, the same recognition of the great desirability of relieving suffering, which in all ages and among all peoples had challenged sympathy and had been recognized as one of the most striking features of humanity. In 1591 a poor woman was burnt in Edinburgh "for employing charms and other means to cast off the pains of labor."[1] Childbirth had been observed to go on with regularity and without suffering under certain pathological conditions of the nervous system. In a case reported by Ollivier the spinal cord was compressed by acephalocysts from the first to the fourth dorsal vertebra. In one observed by Hasse there had been a fracture of the fourth cervical vertebra. There was the case of Deneux, in which delivery took place during the unconsciousness of intoxication from alcoholic drink. Haller had made the statement, based upon the observations of Harvey, Lamotte, and Smellie, that uterine action would continue in a woman "ignara, stupida, et sopita, et immobilis, et apoplectica, et epileptica, convulsionibus agitata; et ad summum debilis."[2] Ramsbotham had made the observation that during the continuance of puerperal convulsions uterine action is *not* suspended, although no signs of pain are manifested by the woman.[1] The same facts awakened in Rush, of our own country, the spirit of prophecy. He "expressed a hope that a medicine would be discovered that should suspend sensibility altogether, and leave irritability or the powers of motion unimpaired, and thereby destroy labor-pains altogether." "I was encouraged to cherish this hope by having known delivery to take place in one instance during a paroxysm of epilepsy, and having heard of another during a fit of drunkenness in a woman attended by Dr. Church, in both of which there was neither consciousness nor recollection of pain."[2]

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[1] Simpson: *Med. Times and Gaz.*, April 4, 1868.

[2] Fredet: *De l'Emploi du Chloroforme dans les Accouchements simples, etc. etc.*, Paris, 1867; Simpson: *Applications of Anæsthesia in Midwifery.*

To Simpson of Edinburgh belongs the honor of having first induced unconsciousness by ether for the purpose of facilitating delivery. The woman's first labor had been terminated by craniotomy after a trial of the long forceps. In her second the head presented, but was high up and movable, and a pulsating loop of cord could be felt floating in the unruptured bag of waters. The pains not causing the head to engage in the pelvis, turning was decided upon; and for facilitating this operation ether was administered for a period of about twenty minutes, when the patient was rendered unconscious and version effected. Delivery of the head was very difficult, and an indentation of one parietal bone was produced by the projecting promontory of the sacrum. The child made a few respirations, but did not survive. The woman testified with wonder and gratitude to entire insensibility to pain during the whole process of delivery, and made a most satisfactory recovery, being up and dressed on the fifth day. This occurred on the 19th of January, 1847. The next case took place on the 3d of February following. It was again a second labor, the first having been instrumental. This time the forceps was applied and delivery effected during complete unconsciousness. Both mother and child were saved. A third case followed on the 12th of February. Ether was administered for the severity of the pains, and this came near being the first case of natural delivery under an anæsthetic, but finally the forceps was resorted to for termination of the labor.[3]

On the 10th of February, Prof. Simpson laid the subject before the Obstetrical Society of Edinburgh at some length, and presented the lessons derived from his experience in the following terms:

1. That the inhalation of ether procured for the patient a more or less perfect immunity from the conscious pain and suffering attendant upon labor.

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[1] *Obstetric Medicine*, 1844.

[2] *Medical Inquiries and Observations*, p. 376—quoted by Channing and alluded to by Simpson.

[3] Simpson: *Works*, "Anæsthesia," etc.

2. That it did not, however, diminish the strength or regularity of the contraction of the uterus.

3. That, on the other hand, it apparently (more especially when combined with ergot) sometimes increased them in severity and number.

4. That the contraction of the uterus after delivery seemed perfect and healthy when it was administered.

5. That the reflex assistant contractions of the abdominal muscles, etc. were apparently more easily called into action by artificial irritation and pressure on the vagina, etc. when the patient was in an etherized state.

6. That its employment might not only save the mother from mere pain in the last stage of labor, but might probably save her also, in some degree, from the occurrence and consequences of the nervous shock attendant upon delivery, and thereby reduce the danger and fatality of childbed; and,

7. Its exhibition did not seem to be injurious to the child.

The gist of the whole matter lies in the second paragraph. The step from surgical to obstetrical anæsthesia was but a short one, it is true, but it was over a chasm of unknown depth. Trial alone could show whether uterine contractions would continue, and thus labor go on, during the unconsciousness of ether. Simpson made the trial not only with boldness, but with that infinite tact which borders on genius. During the operation of turning it mattered little whether the uterus continued to contract or not, and he chose such a case for the first attempt. The fact of uterine contraction continuing during the influence of ether having been verified, obstetrical anæsthesia was established. Simpson himself recognized this as what it in truth is, "the one great fact upon which the whole practice of anæsthesia in midwifery is founded."

The recent warm reception and rapid advance of surgical anæsthesia facilitated the spread of the use of ether in obstetrics. In the course of a short time the new method was tested in the other capitals and cities of the British islands. On the 13th of February, Dr. Murphy of London resorted to it in a case of turning. Mr. Lloyd conducted a case of natural labor with ether on the 27th of March, and Dr. Protheroe Smith one on the 28th; the latter, with two other cases, was published in the *Lancet*, May 1st. Mr. Lansdowne of Bristol had a case on the 1st of April, and soon after reported several cases of the successful use of the new remedy. Dublin did not accept the innovation until a comparatively late period; the first case was one of instrumental labor, conducted by Dr. Tyler on the 28th of November.

In France etherization in childbirth was very early tried. Within a week of the first case at Edinburgh, Fournier-Deschamps delivered a patient under ether by the forceps, and on the 8th of February, Paul Dubois, then at the head of the Maternité of Paris, delivered another in the same manner. By the 23d of that month Dubois had had four other cases, and at that date he formally presented the subject to the French Academy of Medicine, with the following conclusions:

1. The inhalation of ether can annul the pain of obstetrical operations.
2. It can suspend the physiological pains of labor.
3. It destroys neither the uterine contractions nor the contractions of the abdominal muscles.
4. It diminishes the natural resistance of the perineum.
5. It does not appear to act unfavorably on the health or life of the infant.

Toward the end of the year Roux of Toulon published a paper upon the subject,[1] concluding as follows:

1. Ether does not interfere with labor by suppressing the pains.
2. In difficult labors it is desirable.
3. The uterine and abdominal muscles continue to contract under ether.
4. The child is not affected, nor is hemorrhage increased by it.
5. The secretion of milk or any other puerperal process is not interfered with.

Villeneuve of Marseilles and Stoltz of Strasburg published their observations and gave their testimony upon the subject. In Germany the first case occurred on the 24th of February, under the care of Martin of Jena. The ether was administered to facilitate separation and extraction of an adherent placenta. On the 8th of May, Siebold read a paper before the Royal Scientific Association of Göttingen. He had resorted to ether in eight cases, some of them instrumental and some natural. Deep narcotism seems to have been produced, the pains ceased, and this distinguished obstetrician ventured the prophecy that ether would find no favor in natural labor.[2] On the 3d of June, Greuser of Leipsic delivered a patient with the forceps under ether.

In our country the administration of ether in obstetrical practice was not resorted to as early as might have been expected, considering that it was the birthplace of artificial anæsthesia. The first administration took place on the 7th of April, 1847,[3] by which time Simpson had used it over fifty times.[4] It was a case of natural labor, under the care of Dr. N. C. Keep of Boston. The report concludes with the statement that "the result was highly satisfactory." Still, the labor was rapid, the patient was scarcely brought under the influence of the anæsthetic, and, although it is evident that her sufferings were mitigated, the testimony of the case could not have had much weight in favor of the new method. On the 6th of May ether was administered by Dr. Channing in a case of severe and protracted first labor, which was terminated by craniotomy after a trial with the forceps. The second case, on May 15th, was again a primipara, and the labor was terminated by the forceps.[1] It is to be inferred from Dr. Channing's book[2] that these two cases formed the subject of a pamphlet which was issued in May, and a second edition of which appeared in July, by which time he could report seven cases. These pamphlets were the first independent publications in this country upon this subject. Both the cases of Dr. Channing furnish the strongest possible evidence of the beneficial effects of ether during parturition, with entire absence of any untoward influence. Suffering was relieved, while uterine contractions continued; there was also associated expulsive effort, and in one case we have a graphic picture of the earnest demands of the patient for a further supply of the means of relief, which, in the beginning, she had refused to accept.

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[1] *Gaz. médicale*, Oct. 9; *London Med. Gaz.*, Oct. 15, 1847.

[2] *London Med. Gaz.*, iv. p. 1052.

[3] *Boston Med. and Surg. Journ.*, April 14, 1847.

[4] *Brit. and Foreign Med. Review*, April, 1846.

The first period in the history of obstetrical anæsthesia covers the discovery of the facts that uterine contractions would continue, while pain was abolished, and that no deleterious influence was exerted by ether, with the general acceptance of the method for preternatural labors and obstetrical operations. This period was cut short, as to ether, by the introduction of a new anæsthetic agent. Simpson was again the path-breaker. Moved, he tells us, from the first time that he saw ether inhaled, by the conviction that other agents would be found capable of entering the system by the pulmonary circulation and producing like effects, he entered upon a line of experiment and personal trial with various articles. Chloroform, which had been known for about fifteen years, but scarcely otherwise than as a chemical curiosity, was suggested to him by Mr. Waldie, a chemist, and a graphic account has been transmitted of the first trial of the inhalation of this agent by Simpson and his friends, Keith and Duncan.[3] They were immediately impressed with the conviction that they had found an anæsthetic superior to ether, and especially for obstetrical practice. Simpson had been impelled in his search by the manifest disadvantage of ether, especially by its disagreeable and persistent odor, its irritating effect upon the air-passages, and the large quantity required to produce anæsthesia. None of these objectionable features attached to chloroform. The quantity of the new agent required was small; drops took the place of drachms. Its action was more rapid, more complete, and more persistent. Its odor was pleasant, instead of unpleasant or even suffocative. In addition were to be considered a smaller expense and greater portability and the lack of need of special apparatus for administration. With these advantages in its favor there could be no question as to the relative position of the two agents. Chloroform rapidly displaced ether, and almost entirely superseded it.

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[1] *Boston Med. and Surg. Journ.*, May 19, 1847.

[2] *A Treatise on Etherization in Childbirth.* Illustrated by 581 cases. By Walter Channing, M. D., Professor of Midwifery and Medical Jurisprudence in the University at Cambridge: Boston, 1848.

[3] Miller: *Surgical Experiences of Chloroform*, Edinburgh, 1849.

No time was lost in making a trial of the new agent. Simpson had been in search of an anæsthetic especially for obstetric practice, and, emboldened by his large experience with ether, he administered chloroform for the first time in a case of labor and before it had been used for any capital surgical operation. It was a second confinement, the first delivery having been by craniotomy, and occurred on the 8th of November, 1847. After pains had lasted three hours and a half, and the os uteri was nearly dilated, the inhalation of chloroform was begun. The child was delivered in about twenty-five minutes, the mother being entirely unconscious and remaining so until after delivery of the placenta. Soon afterward Simpson again exhibited chloroform to a patient who in a former labor had had severe hemorrhage. She was kept under its influence sixty-five minutes, awoke unconscious of the birth of her child, and had no flooding. The third case was a primipara, twins. In all three cases the efficiency of the new agent in abolishing pain was exemplified and its rapidity of action shown, while no untoward circumstance occurred. During the same month the use of chloroform was extended to general surgery, and the news of its success in both departments rapidly spread to every part of the world, and everywhere its manifest advantages over ether were recognized. The first administration in this country for obstetrical purposes took place in the city of New York, by Dr. A. K. Gardner, as early as Feb. 2, 1848. It was a case of natural labor, and the same physician used it once more during the same month, and again in April for a similar case.[1]

The introduction of chloroform marks the second period in the history of obstetrical anæsthesia. Had it not been for the occurrence of deaths under this agent when given for surgical operations, it would doubtless have held the field alone. The fatal cases, however, surprised and shocked the profession, and exerted a powerful influence in preventing a resort to it or in causing a return to ether. But from this time on, both ether and chloroform were resorted to for obstetric purposes, and must be considered together. One was preferred by some, the other by others. This is no better exemplified than in Dr. Channing's book, which was published soon after the first deaths under chloroform had occurred. While he says that "from the evidence it would seem that chloroform has the advantage of sulphuric ether," and that his "latest experience with chloroform has been the most grateful," he admits that "patient and practitioner have felt the power of the untoward experience."[1] Notwithstanding the special title of his book, he took with him to his cases both chloroform and ether, and used either almost indifferently[2] or both in the same case. Of 516 cases of natural labor tabulated, 358 had ether and 158 chloroform. Moreover, he speaks of "*etherization* from chloroform,"[3] and of "the perfection of *etherization* which chloroform produces."[4]

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[1] *Bulletin N. Y. Acad. of Med.*, vol. i. p. 309.

The third period in the history of the subject comprises the further progress of the method, and especially the contest in regard to the application of anæsthetics to natural labor. The latter is a phase rather than a period, since no sharp line anywhere, at the beginning, separates the use of anæsthetics in natural from preternatural cases. Within three weeks after the first administration Simpson had given ether in "several cases of natural labor."[5] The first case in this country, as has been stated, was one of natural labor. Channing's third, fourth, seventh, eighth, and ninth cases were all natural labors, the first taking place on June 10th. But at first anæsthesia in obstetrics was chiefly resorted to for instrumental or preternatural cases. By the profession it was, for those cases, silently acquiesced in, if not accepted, and awakened no opposition because so similar to surgical anæsthesia, in which its advantages were manifest. With increasing experience, and with an agent more manageable and less unpleasant than ether, the advocates of obstetrical anæsthesia became more decided in their advocacy of the measure as a means of mitigating the pains of ordinary parturition. At once a storm of hostility was aroused, and a controversy awakened which has few equals in the annals of medicine. Medical journals were filled with articles, pamphlets were poured forth, and the debates of medical societies were occupied with arguments upon both sides of the question. It was again the old struggle of conservatism against the spirit of progress. Upon the one side were firm conviction of right and a noble impulse to benefit humanity; upon the other, caution, a wholesome fear of interference with a natural process, and a dread of resorting to so powerful agents unless life were endangered; upon both, without doubt, honesty and conscientious regard for duty.

To relate this contest in all its particulars would occupy far more space than is here at disposal. Only the leading features can be given, with the names of the chief actors. Opposed to anæsthesia in natural labor were Ramsbotham, Barnes, Lee, Montgomery, Ashwell, and Merriman in Great Britain; in Germany, Grenser, Siebold, Sachs, Scanzoni, and the professors of the Vienna School.[1] In this country Meigs, a forcible and elegant writer, occupying a chair in a leading medical college and in the profession a position of commanding influence, conducted the opposition. He entered the lists against Simpson himself, and proved one of the most influential opponents of the innovation. Hodge of Philadelphia and Bedford of New York supported Meigs. Both occupied chairs, both were authors of textbooks, and both enjoyed the respect of the profession. Although not so active in the controversy, they both threw their influence, which was great, against the administration of anæsthetics in natural labor.

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[1] *Op. cit.*, pp. 124, 125. See also "Report of Committee on Obstetrics," *Amer. Med. Assoc. Trans.*, vol. ii. p. 247: "The unhappy result of the surgical use of chloroform has had a most decided influence upon its use in obstetrics."

[2] Pp. 94, 125. [3] P. 119. [4] P. 124. [5] *Anæsthesia*, Philadelphia, 1849, p. 133.

The arguments advanced against the new method were numerous, some of them theoretical and trivial, some of the gravest character. It was argued—

That the mother not having suffered in giving birth to her child, the maternal instinct would be lessened or abolished.

That the practice was immoral—1st, because etherization was similar to intoxication, and therefore was but drunkenness; 2d, as erotic manifestations sometimes occurred under anæsthetics, the lying-in room would be the scene of indecencies.

That it would cause in the patient various neuroses, as paralysis, epilepsy, and insanity, while attacks of convulsions, so often a complication of labor, were directly attributed to the drug, even when they came on several hours after the labor had terminated.[2]

That the pain of labor was physiological, and soon recovered from, conservative, and preservative in action. The total length of time of suffering, on the average, was carefully ciphered, and it was gravely argued that, after all, the lying-in room was, during most of the time, a scene of cheerfulness or even gayety.

That there had been an increase in the rate of mortality in the lying-in hospitals of Edinburgh and of Dublin since the introduction of anæsthesia.

That the procedure was not safe—1st, because of unknown idiosyncrasy on the part of the patient; 2d, because of unknown organic disease from which she might be suffering; 3d, because chloroform was cumulative in action; 4th, because there could be no reliance upon the constancy of the regular succession of portions of the nervous system as affected generally by the anæsthetic; 5th, because anæsthetics caused a status of the capillary circulation, and hence would follow dangerous or even fatal pulmonary congestion.

Finally, and more potent in influence probably than all the others, it was charged that anæsthesia was a sacrilegious attempt to set aside the decrees of Providence; that it was an impious interference with the awful majesty of divine justice, which had sentenced woman to suffer the pangs of childbirth; and that "it would rob God of the deep, earnest cries which arise in time of trouble for help."

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[1] Dutertre: *De l'Emploi du Chloroform dans les Accouchements naturels*, Paris, 1882.

[2] Ramsbotham: *Obstet. Med. and Surgery*, 5th ed. p. 178.

A plea may be entered now for those who conducted an opposition to a great improvement and a beneficent measure, which, since the measure has been established, seems, to say the least, short-sighted. Obstetric anæsthesia was an immense innovation, such an one as will never be seen again. It interfered with a natural process and did violence to long-cherished opinions. Generally, neither surgical nor obstetric anæsthesia was clearly understood at that time. In regard to the one the accepted doctrine was that the insensibility was effected by interference with oxygenation of the blood, and that etherization was asphyxiation. As to the other, the discoverer himself, as will be seen later, carried his patients, in ordinary cases, far deeper under the influence of the agent than is now consistent with the term; as a consequence of this, there was abolition or diminution of the pains and a confusing clashing of testimony.[1] Again, the brilliancy of the discovery led the injudicious into exaggerations, while the description of this new process by bystanders could scarcely fail to frighten those who were not present to witness its beneficent effects.[2]

The leaders of those who championed the cause of progress were equal to the occasion. Simpson was a man of great learning and varied information, while his high position, won by honest effort, gave weight to his opinions. Ingenious in argument, apt in illustration, practical in application, beyond question a lover of controversy, he conducted the campaign with a vigor, an energy, and a perseverance which excited the highest admiration. He brought up from history the opposition which had been made to other improvements in medicine, such as the circulation of the blood, vaccination, and the introduction of Peruvian bark. He collected statistics which showed the deleterious, the fatal effect of pain, *per se*, when long continued. He answered Meigs' plea of "physiological pain," and his description of the lying-in chamber as a scene of cheerfulness, not only with the graphic descriptions of the sufferings of parturition, as drawn by Velpeau and Naegele and Merriman, but with a quotation from Meigs' own writings, in which he stated the pain of childbirth to be simply "*agony*." He rallied philologists to his assistance as to the actual meaning of the words of the original curse; he showed that we interfered with the decrees of Providence in daily life, never more plainly than when the homely fanning-mill was used; and pushed the anæsthetic lesson of the deep sleep into which the Lord threw Adam for the removal of a rib.

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[1] "Etherization would seem to have as many sides as there are observers, and doctrines concerning it seem only limited by the number of observers."—CHANNING.

[2] "All the usual phenomena of the deepest sleep supervene almost suddenly, gliding often into the profoundest of sopor, if not absolutely lapsing into coma. The voluntary muscles become suddenly relaxed, the jaw falls, the arms hang down, the eyes roll upward under the upper lid, the respiration becomes slow and labored, and the face often either pale or morbidly flushed. The aspect of things is indeed such as can hardly be contemplated for the first time without alarm; the individual seems to the common eye to be sinking into the sleep of death."—SIR JOHN FORBES, *Brit. and For. Med.-Chir. Review*, April, 1847.

Among the earliest to appear in print in this country in favor of obstetric anæsthesia, after the reports of cases already mentioned, was Dr. Jonathan Clark of Merion, near Philadelphia. He published two articles upon the subject in the *Medical Examiner*,[1] containing a detailed report of 16 cases in which ether had been administered. "In most cases a perfect etherization destroyed the painfulness of labor even when the patient retained consciousness." There seemed to be no retardation of labor nor any unusual tendency to hemorrhage. The "trials of ether as a torture-saving agent were satisfactory to both physician and patients."

Dr. C. G. Putnam of Boston published a paper on "Etherization in Labor" on the 26th of January, 1848. It had been read on the 27th of December, 1847, and contained reports of 19 cases.[2] The same journal, of February, contained another article from the same writer which bore strong testimony to the safety and beneficial effects of etherization in labor.

A publication of great importance, and doubtless of very great influence, was the report of the Committee on Obstetrics of the American Medical Association, which held its first meeting in the city of Baltimore, May 2, 1848.[3] It is a well-written document, thoroughly scientific in spirit, and presents a careful analysis of the experience of others as well as that of the members of the committee. Without entering into the question of the mode of action of anæsthetics, and disposing of the religious objection to allaying the pains of labor in a short and common-sense manner, the two great questions of the subject are presented: Is the method efficient? Is it safe? The first required no answer. The second is considered at length and answered affirmatively. "The effects of these agents seem in some respects better adapted to the practice of midwifery than to general surgery." The sound advice is given that if the practitioner be timid he should give as small a quantity as twenty drops, and that in this dose "it may be pronounced in all cases safe." The statement is made that up to that time ether and chloroform had been given in about 2000 cases without a death or any deleterious consequences. The benefits of these agents are stated to be relief of pain and allaying of nervous symptoms, and the effect may be kept up for hours with entire safety, together with relaxation of the soft parts and increased secretion of mucus, whereby labor is promoted. "The parturient pains have not been diminished either in force or frequency; relaxation has been promoted; pain and suffering are lessened or entirely annulled; the placenta readily thrown off; and all the circumstances following the birth of the most favorable character." While believing that the majority of natural labors do not need these agents, their use is assented to in any at the last and most painful stage. The paper closes with full directions for the administration of chloroform.

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[1] Vol. iii., 1847, p. 589; vol. iv., 1848, p. 153. It has been impossible to obtain *data* of the appearance of several of the earlier papers.

[2] *Boston Med. and Surg. Journal.*

[3] *Transactions*, vol. i. The report is signed by Harvy Lindsly, George C. M. Roberts, Joshua Riley, C. R. Gilman.

In an appendix to this report are given a few communications from leading physicians. Dr. Channing reports his use of anæsthetics in about 40 cases of natural and other labors up to December 16, 1847. Dr. J. C. Bennett of Plymouth, Mass., has used chloroform in nearly 200 cases "without the least evil result" and with very much benefit. Dr. M. B. Wright of Ohio reports "a considerable number of cases," presumably natural labor. He impresses the value of "a gradual rather than a sudden impression," and believes that, "cautiously employed, the agents under consideration will prove of more value to the human family than any medicinal agent yet discovered."

In the autumn of 1848 the work of Dr. Channing appeared. It is a noteworthy book, from the importance of its subject, from its high character and valuable contents, and from the fact that it is the only work devoted exclusively to the subject in our language. It at once placed its author in a position similar to that held by Simpson in Great Britain; he was recognized as the leader of the great progress. He was worthy of the position and the occasion. Learned, dignified, and endowed with talents, occupying a prominent position as a teacher of obstetrics, he enjoyed the respect and the confidence of the profession in a high degree. Less versatile and less brilliant than the great Edinburgh professor, the service he rendered to the cause was at once effective, solid, and enduring. That service was his book. It is honest, scientific, and convincing. Its keynote is that anæsthesia in labor is *safe*, and the whole question is hinged upon this point alone. It shows the most conscientious study of the subject; honesty of purpose is apparent on every page, while the spirit of partisanship nowhere appears; and it is pervaded with the nobility of the mission of giving relief to suffering humanity. Its report of 516 cases of natural labor, in 158 of which chloroform, and in 358 ether, had been administered, with 52 cases of instrumental or complicated labor, was a solid contribution of facts to the subject never before or since equalled. Its presentation of these facts, its collection of correspondence from other medical men, its clear and dignified argument, could not fail to carry conviction wherever conviction was possible. The work exercised a powerful influence in directing the current of professional opinion, and will always stand among the highest in American obstetrical literature.

Dr. Channing's volume shows that he was supported by about twenty physicians of Boston and neighboring towns, whose experience is given in an appendix. Among those reporting the largest number of cases previous to the middle of the year 1848, and who resorted to anæsthesia in natural labor, were Dr. John Bigelow, 10 cases; Dr. A. R. Thompson, 15 cases; Dr. John Homans, 56 cases; Dr. Simon Packer, 22 cases; Dr. John Jeffries, 10 cases; and Dr. A. Phelps, 27 cases.

Prof. Lindsly of Washington, D. C., also appears as a warm advocate of the safety and benefit of anæsthesia in labor.

The next contributor to the subject was Dr. George N. Burwell of Buffalo. He published very early a "Statement of Fifteen Cases of Labor in which Chloroform was Administered."[1] This paper was followed by several others at intervals, until finally his experience was presented to the Medical Society of the State of New York at the meeting of 1853.[2] This is a most important contribution to the subject. It contains the writer's experience during the preceding five years. In it are presented the results and teachings of 180 cases of labor in which he had administered chloroform. The circumstances and symptoms are carefully noted, the cases are classified and compared, and the patients are even followed up, as far as possible, in regard to after-effects. In all respects it is a work of high character, fully commensurate with the importance of the subject studied, and is, moreover, strikingly original. The observations are all his own. No authorities are quoted, borrowed from, or referred to. Simpson's name is once mentioned, and then only to dissent from his doctrine.

In the West obstetric anæsthesia found a warm advocate in Prof. Henry Miller of Louisville. Occupying a chair in the University and author of an excellent textbook on obstetrics, his testimony in its favor was as influential as it was enthusiastic. The first case of administration of chloroform in labor west of the Alleghanies was in his hands. It was a forceps case, and occurred in February, 1848. The anæsthetic was given for four or five hours before resorting to the instrument. In his book he makes a full, clear, and strong reply to each of the objections urged by Meigs against the practice, enters a powerful plea for the amelioration of the sufferings of women in labor, and renders his testimony, based upon experience, as to the entire safety of the method. Chloroform is "really the safest and most manageable of all the agents at our disposal endued with equal potency." "If it be not urged beyond the degree necessary to annul pain and tranquillize the patient, there is positively no risk whatever in its administration."[1]

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[1] *Buffalo Med. Journ.*, 1848–49, iv, p. 331.

[2] "On the Use of Chloroform in Midwifery," by George N. Burwell, M. D., one of the physicians of the Buffalo Hospital. Issued also as a pamphlet.

In what can be but a sketch of the progress of events it is obviously impossible to mention every one connected with it, much less to make statement of their work.[2] A few names, however, demand exception from their high character, commanding position, the extent to which they enjoyed the confidence of the profession, and the power and persistence with which they urged the claims of obstetric anæsthesia. Dr. Fordyce Barker of New York is one of these. He read a paper before the Academy of Medicine in 1857, which was published in pamphlet form, and another before the same body in 1861.[3] In these he strongly advocated the use of chloroform in labor, examined the indications for, and the objections to, its use, urged its value in natural labor, and expressed the strongest convictions of its safety. He has since published several papers in journals upon the subject, and has continued to advocate anæsthesia, presenting the results of the practice from his large experience down to almost the present date.[4]

Dr. Barker was ably seconded by Dr. George T. Elliot. Occupying the chair of Obstetrics in a leading medical school, endowed with high abilities as a writer and speaker, his influence was of great weight. Moreover, he could testify from an experience rarely equalled. He had been one of the first to avail himself of the anæsthetic powers of chloroform, and had taken it thirty or forty times. He had witnessed its administration by Simpson during some months, and at the Dublin Lying-in Hospital in over a thousand deliveries, and had had an experience with it of nine years in the lying-in hospitals and wards of New York. The testimony of Dr. Elliot, based upon large experience and observation both in private and hospital practice, was of the strongest character as to the benefits of chloroform in labor and as to its safety when properly administered.[1]

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[1] *Principles and Practice of Obstetrics*, Philadelphia, 1858, p. 461.

[2] The following titles of papers which appeared during the first decade of obstetrical anæsthesia are taken from the Catalogue of the U. S. Army Medical Library:

Beech: "Use of Anæsthetics in Rigidity of Perineum in First Labors," *Buffalo Med. Journ.*, 1853–54.

Boerstler: "On the Use of Letheon and Chloroform in Obstetrics," *Proceedings Med. Convention of Ohio*, 1849.

Boling: "On the Use of Anæsthetic Agents, more especially in Parturition," *New Orleans Med. and Surg. Journ.*, 1851–52.

Cook: "Anæsthetization, its Parturient Agency," *Transylvania Med. Journ.*, 1852–53.

Graham: "Chloroformization in Midwifery," *Nashville Journ. Med. and Surg.*, 1856.

Haskins: "Anæsthesia in Natural Labor," *Western Journ. Med. and Surg.*, Louisville, 1850.

Kerr: "Chloroform in Labor," *Western Med.-Chir. Journ.*, 1850.

McLean: "Anæsthesia in Midwifery, with Cases," *New Orleans Med. and Surg. Journ.*, 1850.

Miller, H.: "Report of the Committee on Obstetrics," *Trans. Kentucky Med. Soc.*, 1852–53.

Robertson: "Successful Employment of Chloroform during Labor," *South. Med. and Surg. Journ.*, Augusta, 1848.

Smith, O.: "Anæsthesia in Parturition," *South. Journ. Med. and Phys. Sciences*, Knoxville, 1857.

Stevens: "Chloroform in Natural Labor," *N. Y. Journ. Med.*, 1849.

Knight: "Use and Effects of Chloroform in Labor," *West. Journ. Med. and Surg.*, Louisville, 1855.

The following deserves mention as the prize essay of a State society. It is physiological, experimental, and largely taken up with citation of authorities. The author's experience extended to but 16 cases:

Culbertson: "The Use of Anæsthetics in Obstetrics," *Trans. Ohio State Med. Soc.*, 1862.

[3] *Bulletin N. Y. Academy of Med.*, vol. i., 1861–62, p. 287.

[4] *Philadelphia Medical News*, Feb. 12, 1887.

Dr. Lunsford P. Yandell of Louisville was an able and energetic advocate of chloroform in obstetrics. He presented a plea for it to the State Medical Society of Indiana in 1871, and another to the Kentucky State Medical Society in 1877. In 1870 he made a powerful plea for its safety in the *American Practitioner*, and again advocated its claims in 1878 in the *Louisville Medical News*.

In Great Britain the introduction of obstetric anæsthesia found able advocates. Among the supporters of Simpson were Protheroe Smith, Murphy, Rigby, Snow, Sinclair, Denham, Landsdowne, Beatty, and Carmichael. The first-named, besides the early publication of papers[2] and reports of cases both instrumental and natural, issued a pamphlet on "Scriptural Authority for the Mitigation of the Pains of Labor."[3] Denham presented his experience with chloroform,[4] and replied to Greame's pamphlet[5] on the "Misapplication of Anæsthetics in Childbirth, exemplified by Facts." He showed that the fatal cases adduced could not be justly attributed to the chloroform, and he might have added that in Greame's cases the anæsthesia was in all carried far too deeply. Dr. Carmichael successfully answered an attempt to show that the childbed mortality of Edinburgh had increased since anæsthetics had been introduced:[6] the figures would not bear scrutiny. Sinclair did the same later in regard to the Dublin Lying-in Hospital.[7] He presented his experience with Dr. George Johnston, and proved that the death-rate had not been increased, disease induced, or convalescence prolonged. Landsdowne was "better pleased with the application of anæsthetics to natural labor than to any other cases."[8] Dr. Edward W. Murphy, who occupied the chair of Obstetrics at University College

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[1] *Bull. N. Y. Acad. of Med.*, vol. i.

[2] *London Lancet*, May, 1847.

[3] London, 1848.

[4] "Report on the Use of Chloroform in Fifty-six Cases of Labor at Dublin Lying-in Hospital," *Dublin Quarterly Journal*, Aug., 1849.

[5] London, 1849.

[6] *London Med. Gaz.*, 1850, p. 80.

[7] *Dublin Quarterly Journal*, 1864.

[8] *London Lancet*, May 29, 1847.

Hospital, published a pamphlet of twenty-eight pages,[1] which, based upon personal experience, was a powerful plea in favor of anæsthesia. Beatty of Dublin did good service, not only by the publication of papers,[2] but by his answer to Lee's attack.[3] In December, 1853, Dr. Robert Lee read a paper before the Royal Medico-Chirurgical Society purporting to be a report of 17 cases of labor in which chloroform had been inhaled with most pernicious effects.[4] The paper was written in a spirit of bitter partisanship, and contained evident exaggerations, even personal denunciations and disgraceful charges against the supporters of anæsthesia. In a scientific light it would not bear examination; the cases were merely stated, not detailed as to time, place, and particulars. Rigby and Snow addressed frequent articles to the profession. The publication of the treatise of the latter in 1857 came at about the close of the contest, and added a classical work to the literature of the subject.

In the month of April, 1853, an event occurred which exerted a greater influence upon the progress of obstetric anæsthesia in Great Britain than all the efforts of scientific men. It was the acceptance of the method by the queen. In her seventh labor, when Prince Leopold was born, chloroform was administered to her by Snow. Nothing could exceed the astonishment with which the announcement was received, and the tone of the leading medical journals showed but too plainly what would have been the sentence passed upon Her Majesty's attendants, Locock, Grant, and Ferguson, and the administrator, had anything untoward occurred. There is not one word of congratulation for either medical men, the royal patient, or for humanity. "In no case could it be justifiable to administer chloroform in a perfectly ordinary labor," said the *Lancet*.[5] Doubtless all concerned felt the "awful responsibility" of the undertaking, but, having been successful, it had the immense influence upon the people always exerted by royalty. The practice rapidly spread, especially among the aristocracy, and the illustrious sovereign whose reign has seen so many notable achievements may congratulate herself upon a personal participation in the greatest one of the age, or of any age, so far as the suffering of her sex is concerned. In all time to come for this service homage is due to her as the woman rather than as the queen.

Obstetrical anæsthesia did not receive a warm welcome in France. The contest in regard to it has been bitter and prolonged, and presents some special features which deserve attention. Indeed, it has not yet terminated, and within even a few years a controversy which closed in Great Britain a quarter of a century ago has been carried on with warmth and violence, and to-day the majority of her leading authorities do not accept the method. By the testimony of her own writers France has always been slow to accept improvements originating in other countries. Premature artificial delivery did not obtain a foothold until sixty years after it was established in other countries, and then only in the face of violent opposition.[1] Surgical anæsthesia was not resorted to for severe operations in provincial towns at a period twenty years after its discovery.[2] The non-acceptance of anæsthetics in natural labor might seem strange after the very favorable report of their action which was presented by Dubois to the Academy of Medicine so early as February, 1847. But Dubois appended to this report an opinion that they should not be generally resorted to in labor; which drew from Malgaigne the severe but just remark that an immense chasm separated the practical from the scientific conclusions of the distinguished obstetrician. Dubois then stood at the head of obstetrics in France. He was intellectual, sagacious, prudent, but a temporizer and timid. Two of the fifteen patients anæsthetized by him died of puerperal fever, and to this has been attributed his bias against the measure. Much more probable, however, is Pajot's explanation, who refers it to a surgical case, removal of mammary gland, in which dangerous symptoms from chloroform were manifested. However, the sentence was promulgated, obstetrical anæsthesia disappeared in France, and remained almost entirely ignored for many years.[3] For this result Dubois was mostly responsible, although Buisson, in a pioneer work of great value,[4] helped to perpetuate it by his adverse opinion as to anæsthesia in natural labor.

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[1] *On Chloroform in the Practice of Midwifery*, London, 1848.

[2] *Dublin Quar. Journ.*, Aug. 1, 1850.

[3] *Contributions to Medicine and Midwifery*, Dublin, 1866.

[4] *Amer. Journ. Med. Sci.*, Jan., 1855.

[5] May 14, 1853.

The subject was brought forward again in 1854 by Houzelot, who read a paper, based upon 20 cases, before the Société de Chirurgie, published also in pamphlet form.[5] The paper was referred to Laborie, and a warm debate took place upon his report, which closed, however, with its adoption. One of the terms of the report was that "the administration of chloroform in simple labors is considered good." In 1857 appeared the important thesis of Blot.[6] It admitted the abolition of the painful element of labor by anæsthetics without interference with uterine or muscular contractions, the diminution of the perineal resistance, and an entire harmlessness for both mother and child. Nevertheless, the author rejected their use in natural labor. So also did Stoltz in his article on "Accouchements" in the *Nouveau Dictionnaire pra-*

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[1] Joulin: *Traité des Accouchements*, 1866, p. 644.

[2] Dutertre: *De l'Emploi du Chloroforme dans les Accouchements naturels*, Paris, 1882, p. 16.

[3] Dutertre: *op. cit.*

[4] *Methode anœsthésique*, 1850.

[5] *Mémoires de la Société de Chirurgie*, 1853–54.

[6] *De l'Anesthésie appliqué à l'Art des Accouchements.*

*tique.*[1] The powerful influence of the classic work of Maurice Perrin was also adverse,[2] although the arguments are entirely theoretical, the admission made of an entire lack of instances of injurious effect, and the judgment evidently rendered upon a fear of what might possibly come to pass.

Anæsthesia had also to meet the opposition of two teachers, pupils and successors of Dubois, and who succeeded to his position in obstetrics in France—Depaul and Pajot. The former, while fully admitting the immense advantages to be derived from anæsthesia in operations and obstetrical manœuvres, rejected it in natural labors—

"1. Because the employment of anæsthetics, whatever may be said to the contrary, is not without danger, and the woman may be killed.

"2. Because the anæsthetic sleep, in depriving her of reason, does not permit her participation, to an extent almost always necessary, in the great act which she accomplishes.

"3. Because the danger which I have stated is not compensated for by the advantage which results from the diminution or suppression of pain."[3]

The first count of this indictment is supported by the grave charge that the advocates of anæsthesia suppress fatal cases, and by the statement that he knows of two deaths in Paris. The latter statement has the usual fatal weakness of omitting time, place, and circumstances. In the heat of his opposition Depaul took up two positions, both of which are entirely untenable, both as singular as they are false. The first is, that there is no such thing as relief of pain short of surgical anæsthesia; "there is no such thing as demi-anæsthesia." The second is, that all relief experienced by the woman is imaginary. "You sacrifice to the exaggerated pusillanimity of a woman, who, ignorant most generally of the real pain of labor, believes herself [*se figure*] to have suffered much less than if chloroform had not been administered." "The chloroformists simulate an anæsthesia which they do not produce, and address themselves more to the imagination of the woman than to her physical sensibility."

Pajot is the author of the article "Anæsthésie obstétricale" in the *Dictionnaire encyclopédique des Sciences médicales*[4]—a fact which indicates at once his position and his influence. While accepting anæsthesia fully for all obstetrical operations, he will only admit of it in a labor terminated by the natural powers under certain conditions—"perhaps toward the termination of expulsion, in some exceptional cases of women completely unreasonable, deaf to all exhortation, who make efforts to get up, uttering horrible cries, and threatening danger to the infant." But in a paper of controversial character published in the

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[1] T. i., 1864.

[2] *Traité d'Anæsthésie chirurgicale*, 1863.

[3] *Leçons de Clinique obstétricale*, Paris, 1872.

[4] T. iv., 1876.

*Annales de Gynécologie* and also in pamphlet form[1] the opposition of Pajot to this method is more pronounced and his spirit of partisanship is fully revealed. He is bitter, sarcastic, and denunciatory. For him also there is no such thing as "demi-anæsthesia;" it is all surgical anæsthesia or nothing. The patient is either imposed upon or deceives herself, or she is rendered insensible, motionless, and speechless. The "*pretended*" demi-anæsthesia is likened to medals and blessed waters, and termed "anæsthesia of the thirtieth dilution;" it is an error which he will expose as one of the errors "of Simpson, an *esprit* more brilliant than judicious."

"The employment of chloroform in natural labor has the chances of surviving a long time with the women and their attendants, who, thanks to the equivocation and their ignorance, confound *l'anæsthésie à la reine* with true anæsthesia. The irresistible illusion of the 'without pain' will not disappear even before the reality. Women will be made to believe that they would have suffered much more without demi-anæsthesia. Chloroform is, for the accouchées, what Providence is for him who has broken a leg; it is to be thanked, for he might have broken two."

This paper of Pajot's was a reply to two articles in favor of anæsthesia in natural labor published in the *Journal de Thérapeutique* in 1874. They were by Charles James Campbell, an Englishman educated and domiciled in France. He had been the *chef de clinique* of Dubois for two years. He was the leader of the Anglo-American colony in Paris, in which obstetrical anæsthesia was preserved from utter extinction.[2] "Learned, skilful, of good presence and charming manners, he enjoyed the favor of the court of the Second Empire, while his success in practice and his skilfulness as an obstetrician were bywords in Paris."[3] He had introduced anæsthesia into his practice at an early period, having published a paper upon it in 1849: this amelioration of the sufferings of labor had brought him crowds of wealthy patients and placed him in the front rank of obstetricians in the French capital—facts which were not likely to make his methods acceptable to rivals or to soften a controversy concerning them. At the International Congress held at Geneva in 1877, Campbell presented a memoir,[4] the first part of a work which was to be a complete treatise upon obstetrical anæsthesia. It is somewhat prolix — necessarily, perhaps, because largely controversial—yet it is clear, forcible, and convincing, a powerful plea for the relief of suffering of the sex. It is largely occupied with the proof of "demi-anæsthesia"—that there was a stage of insensibility to pain without loss of consciousness, denied by Depaul and Pajot. And most singular it is that labored argument should need to be addressed to eminent and practical men to convince them of a fact which a few observations in the lying-in room, or, better still, a single personal trial when suffering from pain, would have placed beyond doubt. To theoretical objections Campbell could oppose facts. In his book he presented the results of his practice—chloroform administered in more than a thousand labors, and without danger, without any unpleasant effects, and with the immense advantage of a notable diminution of suffering. This and much of practical character in the book made it, like Channing's work, a most valuable contribution to the subject and ensured a weighty influence. Death removed the author before the work could be completed, but his name deserves a place, as a promoter of obstetric anæsthesia, only below that occupied by the names of Simpson and Channing.

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[1] *Le Chloroforme dans les Accouchements naturels*, par le Professeur Pajot, 1875.

[2] Dutertre: *op. cit.*

[3] "Obituary Notice," by Playfair, *Obstet. Journ. Great Brit. and Ireland*, 1880, February.

[4] *Considérations nouvelles sur l'Anæsthésie obstétricale*, Paris, 1877.

The controversy was continued by numerous able writers. Pichaud supported Campbell at the Geneva Congress. Hervieux, although conservative, expressed the opinion that "if we had not chloroform we would be obliged to invent it," and says that "the sum of its advantages far outnumbers its dangers."[1] Courty threw his great influence in favor of anæsthesia in natural labor, giving his experience with 40 cases which had been "most satisfactory in every respect."[2] Dumontpallier read a paper before the Société médicale des Hôpitaux in which he clearly recognizes true obstetrical anæsthesia, and declares it to be "never a danger," making a strong plea for a more general resort to it. The debate which followed in the Hospital Medical Society was generally favorable to the method. Lataud boldly claims that "no authentic fact exists which could cause us to doubt the immunity of obstetric chloroformization."[3] Upon the other side appeared Pinard with a thesis based upon 23 cases, in which he denies demi-anæsthesia and rejects chloroform in natural labor.[4] It is conceded to be a work of high value based upon clinical research, although the number of observations is limited.

After this long controversy and presentation of observations the administration of anæsthetics in natural labor is not established in France. It is to-day condemned by the teaching officials of the country.[5] Of the later textbooks, Joulin alone accepts and recommends the measure,[6] beliving that "the rejection of chloroform in natural labor by the majority of French authors does not rest upon any practical and serious basis." Cazeaux[1] follows the majority in restricting anæsthetics to the operations of obstetrics. His objections, besides that of possible danger, are but poetical rhapsodies. Possibly, the patient should be consulted as to whether she would rather be spared agony or have "her imagination clear to revel in the approaching joys of maternity" or to experience the "ineffable joy at hearing the first cry of the newborn." Charpentier, in his late encyclopædic work,[2] cannot quite accept Pajot's and Depaul's doctrines, and seems disposed to gratify a suffering woman even if the effect be only imaginary. He does not recommend obstetric anæsthesia, and he "does not believe that he is authorized to reject it in labors even the most natural."

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[1] *L'Union médicale*, Aug., 1878.

[2] *Gaz. hébd.*, Oct., Nov., 1878.

[3] *Gaz. hébd. de Méd. et de Chir.*, Jan., 1879.

[4] *De l'Action compareé du Chloroforme, du Chloral, et de la Morphine chez la Femme en Travail*, 1878.

[5] Dutertre: *op. cit.*

[6] *Traité des Accouchements*, Paris, 1866.

The use of anæsthetics in obstetrics has been as carefully and as thoroughly studied in Germany as in any other country of the world. Their physiological action has been especially investigated by Kiwisch, Martin, Schroeder, Spiegelberg, and Braun. The original papers and works not being accessible, it is impossible to give the share which each took in the advance. In the leading textbooks of that country anæsthesia is advised for all operations and under special circumstances, but generally rejected for natural labor. This is the doctrine of Naegele (1867), and it remains unchanged in the French translation by Aubenas (1880). Spiegelberg (1878) teaches the same. So does Zweifel (1887) in the latest textbook upon the subject. Schroeder, in his *Handbuch* (1871) says there is no reason why the physician should not exercise his most pleasing calling of relieving pain, and that the degree of narcotism necessary for relief is absolutely without danger.

It has been shown that the use of anæsthetics in natural labor was accepted in English-speaking countries at an earlier period and more readily than in other parts of the world. Just when acceptance of the practice became general it is impossible to say, for no single event marks it. The contest lasted something more than a decade after the discovery. Numerous influences concurred to produce the final result. Another confinement of Queen Victoria occurred in 1857, and again exerted a powerful influence with the laity. The publication of an able article addressed to this class in the *Westminster Review* for January, 1859, doubtless had a great effect. Snow's classic work appeared in 1858, and aided much in placing the method upon a scientific basis and promoting its acceptance by the profession. So also did the report of the Chloroform Committee of the Royal Medico-Chirurgical Society,[3] in which the matter was no longer questioned, but treated as settled. Formal opposition may be said to have ceased with the appearance of the fifth edition of Ramsbotham's work on *Obstetrics* in 1867. In this are reprinted all the objections and arguments of the preceding edition, occupying more than thirty pages, and then the whole is retracted. The retraction is made but grudgingly, it is true, yet it is made.

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[1] *Traité des Accouchements*, 9th ed., by Tarnier, 1877.

[2] *Traité pratique des Accouchements*, t. i., Paris, 1883.

[3] *Med. Times and Gaz.*, 1864, ii. p. 76.

In this country the contest ceased with the passage of the original opponents from the stage of life. No new ones arose, and anæsthesia in natural labor is everywhere theoretically accepted. Yet it did not spread with that rapidity, nor is it at this time so generally accepted, as might have been expected in the country which gave birth to anæsthesia, and which has furnished so much and so strong evidence in favor of its application to obstetrics. Channing complained of the apathy of the profession in regard to it; a year after the discovery the number of cases which, with industry, he could collect did not much exceed five hundred. Miller says the practice rather crept than flew over the country. And now, it is believed, there is not such a general resort to anæsthetics in natural labor as so great a boon to suffering woman deserves or as is consistent with the second great object of the profession—the relief of pain. This certainly is not the effect of any records of accident or disaster in obstetrics, for such do not exist. The result must rather be attributed to the bad name which chloroform has acquired in surgical practice, and a prejudice against it resulting therefrom. A good deal, too, must be attributed to the very strong conservatism manifested by some of our leading teachers, and still more, perhaps, to a lack on the part of the profession of that careful study which so important a subject demands. "Few practitioners give themselves the trouble to master the necessary *modus operandi* of the use of anæsthetics, to study the limitations of their usefulness, or to learn the conditions of their safe administration."[1] The general neglect of the method is to be deplored alike in the interests of the profession and of humanity.

## OBSTETRICAL ANÆSTHESIA.

General anæsthetics are administered in labor in two distinct classes of cases:

1. In obstetrical operations and painful manœuvres;
2. In normal labor to mitigate or annul pain.

In the first class of cases the administration differs in no essential point from that of surgery. More important in obstetrics because two lives are at stake, deep anæsthesia is the same in the one as in the other, and but a few points require special consideration.

In the second class, however, the process is a special one and demands careful study. The object here is to alleviate or annul suffering without abolition of consciousness; the sensations of the patient are to be kept in abeyance, while her relations with the external world remain but little disturbed.

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[1] Lusk's *Obstetrics*, 1886.

As this result is attained at a certain portion of a process, a farther stage of which is the condition of deep narcosis required for surgical operations, it is unfortunate that we have no other word in our language to designate it than the one used for the full effect—"anæsthesia." Simpson recognized this fault in our language, and expresses regret that he did not adopt the word "nodynia" (νοδυνια). The term "demi-anæsthesia" was applied to the condition in France, but has not been adopted. "Analgesia" is the best word we have, and this and the term "obstetric anæsthesia" will be used here to designate that part of the anæsthetic process in which pain is relieved or abolished while consciousness remains.

The physiological basis of obstetric anæsthesia is the fact that the action of anæsthetics is regularly progressive, affecting first the lower portions of the nervous system, and ascending gradually to the higher. Experimental proof of this was furnished by Flourens and Longet as early as 1847, and repeated by Bernard.[1] First, the lower part of the spinal cord is affected, then the dorsal and cervical portions, finally the medulla oblongata. The intellectual processes are early disturbed, then comes loss of perception of external impressions, as of touch and the special senses, then entire loss of consciousness, while sensibility to internal impressions remains, and reflex actions arising from them are only abolished later. In labor the contractions of the uterus continue after consciousness is lost; they will be excited to increased energy upon passing the hand into the organ even in a condition of deep narcosis. At a more advanced period this internal or unconscious sensibility, if the term may be used, is also abolished, the reflex actions dependent upon the medulla oblongata (respiration and circulation) cease, and life is extinguished.

All writers upon anæsthetics have based upon this progressive action of the agents a division of their effects into stages. The number of these stages has varied very much with writers. The important fact is, however, that the process is a continuous one, and that no arbitrary lines separate different portions of it; they glide imperceptibly into each other. Personal experience can alone give a clear understanding of the gradually progressive action of anæsthetics, and personal experience *during pain*. Based upon such experience, issue is taken with all those who place disturbance of the intellectual processes or interference with consciousness among the first effects of the inhalation of chloroform. *Relief of pain* precedes everything else, except a glow of stimulation and a sense of fulness in the head. The fact is important in its bearings upon the subject under consideration, and error as to the succession of events has had its origin in two sources—inhaling the anæsthetic when free from pain, and inhaling it too rapidly. Those who would test the matter should do it when suffering, and use very small doses, inhaling slowly.

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[1] *Leçons sur les Anæsthétiques et sur l'Asphyxie*, Paris, 1875.

Obstetrical and surgical anæsthesia are, then, although parts of the same process, very different in many respects. The one lies between loss of consciousness and that deep narcotism which is dangerous; the other stops before consciousness is entirely abolished; the one is a fixed condition attained directly and maintained constantly; the chief characteristic of the other is its mobility—it varies with almost every act of respiration. During different stages of the same labor it is frequently necessary to pass from one to the other, carrying the patient deeper under the anæsthetic as the pain augments; and this is easily done, while to hold her, during a considerable period of time, in the condition of analgesia is a difficult and delicate task, requiring the closest watchfulness and constant attention.

## DIFFERENT ANÆSTHETICS.

The superiority of chloroform over ether for the production and maintenance of obstetric anæsthesia is manifest. The historical sketch has shown that the advantages of small quantity, rapidity of action, and pleasantness immediately carried the suffrages of the world in favor of chloroform against an agent which produces a marked period of excitement, which is unpleasant to inhale, and which requires for administration a special apparatus, or, in default of one, loads the atmosphere of the apartment with its vapor. Moreover, this vapor is highly inflammable, and the danger of accident from its ignition was recognized by Channing. Since it will take fire at a distance of fifteen feet,[1] it is a fact which demands serious consideration. Chloroform has one quality which peculiarly fits it for the purposes of the obstetrician —its *manageability*. This is, of course, dependent upon its power. Speaking from personal experience, during inhalation the effect of a single inspiration can be plainly distinguished, and the importance of the fact in a process where frequent recurring and intermittent pain is to be met is apparent.

Ether can receive consideration as an anæsthetic in obstetrics only on the ground that it is "the safer anæsthetic." Such a statement has been made.[2] But if this statement be founded upon surgical practice, it has no statistical basis. Theoretically, ether is the safer anæsthetic, and on that ground it is preferred by the majority of surgeons in this country, while it is gaining ground in Great Britain. Yet its superior safety is not sufficiently apparent to induce the surgeons of France, Germany, or Italy to adopt it. In those countries, with their immense surgical practice, chloroform is almost universally the anæsthetic.[1] And those who have carefully studied the subject are firmly convinced that if the mortality of each agent, with the number of administrations, were accurately known, there would be but little difference. "The difference between the mortality of chloroform and that of ether is far from being as great as has been attempted to be shown. . . . . My conclusion is: chloroform is not as fatal, nor ether as innocent, as they have been represented."[2]

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[1] Squibb: *Ephemeris Mat. Med.*

[2] Parvin: *Science and Art of Obstetrics*, 1886.

In some parts of this country, however, ether is used almost exclusively in obstetrics. This is the case in Boston and probably throughout New England.[3] It is also the case in Philadelphia.[4] The choice cannot be made upon any superior advantages of ether in obstetrics, for none such have been laid before the profession. The lamented George T. Elliot made a comparative study of the two anæsthetics, and found no difference in their effect upon the labor-pains. Stoppage or diminution of their force, "which demands that chloroform should be occasionally denied to a patient, is produced as readily by ether."[5] It is also a notable fact that at a meeting of a leading medical society held in the city of Boston a strong paper was read upon the possible danger of chloroform in obstetrics, yet it elicited not a word in presentation of the superiority of ether.[6] But one recent textbook of obstetrics distinctly recommends ether to the rejection of chloroform.[7] Wherever ether is used instead of chloroform, it is on account of a belief in its greater safety which is not founded upon facts, or in deference to a prejudice which exists in the public mind against chloroform in many parts of the country.[8] This prejudice on the part of the laity is but a reflex from the professional mind; it is not warranted by the facts, but, like all prejudices, is mostly the result of ignorance.

In surgery an attempt has been made to avoid the dangers of chloroform and the disadvantages of ether by using them together, or by a combination of the two with alcohol. This plan has been pursued to a limited extent in obstetrics. It was made the subject of a special treatise by Dr. Ellis,[1] but, unfortunately, his plan required a complicated and expensive apparatus, and, although his little work is of high scientific character, it has had but moderate influence. A strong plea for the mixed vapors was made by Dr. Sansom before the London Obstetrical Society.[2] He advises the use of a mixture of one part of chloroform to two of absolute alcohol. The alcohol in all these mixtures acts not only as a diluting agent, but "by restraining volatilization favors admixture with air." Dr. Edis states that he has been long in the habit of using a mixture of equal parts of chloroform and ether, and "believes the tendency to hemorrhage to be less than with chloroform alone."[3] Dr. Isaac Brown wrote in favor of chloroform two parts, alcohol one part, with the addition of cologne.[4] Dr. Playfair says: "For years I have used in my clinic Billroth's mixture—chloroform, 100; ether, 30; alcohol, 30, by volume—and find it preferable because the narcosis is quieter and attacks of heart-weakness do not occur any more."[5] In this country a mixture of chloroform one part, ether three parts, alcohol two parts, was advocated by Dr. Barr before the Obstetrical Society of Philadelphia.[6] Dr. Halberstadt of Pennsylvania read a paper before the Medical Society of that State in 1878 upon the use of the alcohol-chloroform-ether mixture in obstetrics.[7] It was based upon a large experience, and gave expression to strong convictions of the advantages of this combination. The writer has had a large experience with this mixture, having used it almost exclusively in surgery since its introduction. He has not, however, made use of it in obstetrics. The additions to the chloroform are efficient chiefly as diluents. They therefore obviate one of the great dangers of chloroform, that arising from the sudden inspiration of too powerful vapor. The only objection to the use of the mixture is the slower production of effect, rapidity of action being a quality of pure chloroform which peculiarly adapts it to obstetrics. Of these mixtures, Dr. Sansom's is doubtless to be preferred, but "the best diluent of chloroform is air."

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[1] Everywhere, so far as the writer could ascertain in a recent journey, except in the city of Lyons, where ether is used, and at Vienna, where Billroth uses a mixture of chloroform and ether.

[2] Gubler: *Commentaires thérapeutiques*, Paris, 1884.

[3] Parvin's *Obstetrics*, p. 394: cases of ether administration in labor, 323; of chloroform, 2.

[4] Letter of an obstetrician of the city to writer; Harris, notes to Playfair's *Midwifery*.

[5] *Obstetric Clinic*, p. 65.

[6] *Trans. Amer. Gyn. Soc.*, vol. ii.

[7] *Manual of Obstetrics*, by A. F. A. King, 3d ed., Philada., 1886.

[8] *Textbook of Modern Midwifery*, by Rodney Glissan (Oregon), 1881; letters to the writer from Philadelphia.

## CHLOROFORM: ITS DANGERS.

Chloroform, being best adapted for obstetrics, and being the anæsthetic preferred in the vast majority of cases, is alone considered here. The first question in regard to it is one already foreshadowed in the preceding section: What amount of danger is there from its use? The most searching inquiry upon this point is imperative, since time has strengthened, in surgical experience, the strongest objection ever made to obstetric anæsthesia. It was urged by Meigs that there was not, and could not be, any assurance that the order in which the different portions of the nervous system succumbed to ether was reliable, and that irregularity in this respect could entail sudden death. The highest authorities have recognized the irregularity of action of chloroform when given in full doses.[1] A statement of this fact might seem to carry with it an abandonment of the agent. It would do so were there not, as a counterpoise, an experience which can be justly termed immense. The records of that experience have been carefully searched, and every case as closely scrutinized as possible. There have been a good many cases reported in which death was imputed to chloroform, but with manifest injustice. Justice and science alike demand that the remedy shall not bear the odium of causing death unless it has been properly used and under circumstances in which it alone could have been the cause of death. It is impossible to present here the details of all these cases: in some of them the administration was by an incompetent person, in others by the patient herself. Many of them rest only upon hearsay evidence; time, place, and persons of the occurrence are entirely lacking. In a number some severe complication of labor was present, such as convulsions or placenta prævia, which frequently alone is a cause of death. Until recently it could be truthfully said that not a single death had ever taken place under chloroform in labor when it was administered by a competent person. The following, however, occurred in the practice of Dr. W. K. Harrison of Chicago in 1881:

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[1] *On the Safe Abolition of Pain in Labor and Surgical Operations by Anæsthesia with Mixed Vapors*, London, 1866.

[2] *Transactions*, vol. x.

[3] *Brit. Med. Journ.*, Nov. 16, 1872.

[4] *Med. Times and Gaz.*, May 11, 1867.

[5] *Obstet. Journ. Great Brit.*, viii. 2, p. 76.

[6] *Amer. Journ. Obstet.*, xiii. p. 390; *Med. News*, April 18, 1885.

[7] Turnbull's *Manual of Anæsthetics*: alcohol, 1 part; chloroform, 2; ether, 3, by volume; recommended by Royal Med.-Chir. Society, 1864.

Patient aged 36, primipara, in good health, weight 145 pounds; urinary secretion normal. Had been in labor eight hours; os fully dilated, head descending. The severity of the suffering caused her to insist upon chloroform, and she inhaled, intermittingly, a few drops from a handkerchief. She did not become unconscious, and at the end of ten minutes began to complain of thoracic oppression and dyspnœa, and desired to be raised into the sitting position. She was raised up, and immediately the neck and face became livid. She was at once placed in the horizontal position, but had already become unconscious. She frothed slightly at the mouth, the cheeks were blown out in expiration, and after half a dozen sighing respirations at increasing intervals she ceased to breathe. The condition of the pulse was not observed. Child was not delivered, and there was no autopsy.[2]

The symptoms point strongly to embolism of the pulmonary artery, and it is to be deeply regretted that no autopsy was held. The administrator, who was experienced, is firmly convinced that the death was due to chloroform.[1]

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[1] See Holmes's *Surgery*, Am. ed., vol. iii. p. 542.

[2] *Artificial Anæsthesia and Anæsthetics*, by Henry M. Lyman, A. M., M. D., 1881, p. 194.

The inquiry as to fatal accidents from chloroform is singularly facilitated by the bitter controversy which was carried on in France, as shown in the historical sketch. Repeatedly the statement was openly made, and even as late as 1879,[2] that no death in labor had ever occurred under chloroform. Thus challenged, the opponents of anæsthesia, Depaul and Pajot, did not adduce a single instance, but conducted their opposition upon the ground that chloroform was useless, not that it was dangerous.

That there have not been more deaths when chloroform has been used is most extraordinary, when it is considered that sudden death in labor is not so very rare an event. It is an "appalling occurrence which many, perhaps most, men of much experience have witnessed at least once in their lives,"[3] and the causes of which "rest yet under a veil of profound mystery."[4] Two such cases have occurred to the writer — one just after labor began, and one puerperal — in both of which, had chloroform been administered, it would have borne the blame of the catastrophe. Looking at the number of such cases which have been reported and at the result of the search for deaths under chloroform, and it again seems that a satisfactory explanation can only be found by assuming the existence of some special safeguard attaching to the parturient woman.

The occurrence of dangerous symptoms during the inhalation of chloroform in labor is of equal import with cases of death, and deserves as careful study. The same careful and extended search has been made as in regard to deaths, and the number of cases found recorded is surprisingly small. McClintock reports one, in which dangerous symptoms supervened during inhalation for rigidity of the os.[5] Elliot gives a case in which respiration suddenly ceased after inhalation of small doses had been continued for some time.[6] Lusk reports a case, labor in second stage, inhalation of small doses during two and a half hours, when the patient suddenly ceased to breathe and the pulse became imperceptible. In all these cases the bad symptoms followed immediately upon taking a few deep inspirations, and in two of them a fresh supply of the anæsthetic had just been poured on the compress.[1] Sinclair gives a case in which, after the inhalation of half a drachm of chloroform for about half a minute, "the pulse suddenly failed and respiration appeared to have ceased."[2] Gilman reports a case in which a patient suddenly ceased breathing "after four or five deep inspirations." She had just been bled, and was therefore in a condition peculiarly susceptible to the action of the anæsthetic.[3]

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[1] The following case was reported by Dr. R. G. Curtin to the Obstetrical Society of Philadelphia, "as related to him by another physician:"

A. T., age 26, primipara. Chloroform was administered with a view to application of forceps. Patient cheerful and in good condition. About a drachm of the anæsthetic was inhaled, when the patient quickly became livid, her breathing ceased, and life was terminated.—*Amer. Journ. Obst.*, xiii. p. 391.

[2] *Gaz. hebd. de Méd. et de Chir.*

[3] Churchill's *Midwifery*, 3d ed., 1855.

[4] Hervieux: *Maladies puerperales*, t. ii., Paris, 1870.

[5] *Amer. Journ. Med. Sci.*, Oct., 1853, p. 531.

[6] *Obstetric Clinic*, and Case ii. of Lusk's paper.

There are some other cases in which the cause of the bad symptoms is apparent. In Boinet's case, a forceps delivery, the administration was committed to the husband, who became too much interested in the operation.[4] In one of Lusk's cases there was gross maladministration; the administrator "crowded the paper funnel, which contained a towel wet with the agent, over the respiratory passages." In another the patient had been in labor eighteen hours, then was delivered with the forceps in an hour, after which there was a severe post-partum hemorrhage.

The following is the only case found of danger occurring in obstetrics with anæsthesia carried to the surgical degree:

Patient aged 21, primipara at full term, presenting all the appearances of excellent health. Pains began in the night, and by 9 A. M. were severe. L. O. A.; os as large as a franc-piece. At 10 o'clock pains intolerable; chloroform given, at first as an analgesic, later to narcotism. From the first inhalations respiration was very irregular, sometimes fast, sometimes slow; under the deeper influence it became regular. At noon dilatation complete, membranes ruptured, chloroform withdrawn. At 1 o'clock the anæsthetic was resumed on account of the severity of the pains. The patient went promptly to sleep without excitement, when, at 1.15, the compress being nearly dry, "she slowly ceased to breathe, without stertor, without falling back of the tongue. The face, especially the lips and eyelids, became livid; then respiration and circulation ceased entirely." The head of the patient was promptly lowered, and mouth-to-mouth artificial respiration began. At the end of a minute and a half an expiration occurred, soon after an inspiration, and at the end of about two minutes more respiration was established. Child born alive. Convalescence normal.[5]

A faithful effort has been made to present the whole truth in regard to danger and death from chloroform during labor. The effort has extended to the literature, periodical and standard, of several countries. The meagreness of the result is striking.[6] It may be said that many cases of dangerous symptoms have never been reported. This is doubtless true. But the same may be said of ether with equal truth.[1] There must be contrasted with the number of accidents here reported the amount of experience from which they have been gathered. It cannot be given in numbers; twenty-five years ago it was stated that one hundred thousand women had been delivered under chloroform; it can only be said that it nearly covers the experience of a large portion of the world for forty years or since the discovery of the method. The safety of anæsthesia in labor is not to be shown by argument; it depends upon facts. "The teachings of etherization are from experience;" and if chloroform in labor is to be rejected on account of danger, then, to be consistent, every powerful agent of the materia medica should be given up, or even the comforts and appliances of common life, as vehicles and railroad cars, should be abandoned.

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[1] "On the Necessity of Caution in the Use of Chloroform during Labor," *Trans. Amer. Gyn. Soc.*, vol. ii.

[2] *Dublin Quar. Journ.*, Aug., 1864.

[3] *Bull. N. Y. Acad. of Med.*, vol. i. p. 292.

[4] *Ibid.*, p. 350, and *Amer. Journ. Med. Sci.*, Oct., 1853, p. 529.

[5] "Des Accidents du Chloroform chez les Femmes en Travail," par le Dr. Carafi, *Archives de Tocologie*, 1882, p. 193.

[6] A critical examination of the paper by Dr. Lusk, already referred to and quoted

There are many circumstances attending parturition which tend to ward off or prevent danger from the administration of chloroform. Sex is one of these; the record of deaths from this agent shows nearly 2 men to 1 woman.[2] The recumbent position of labor is an element of safety. Emotion is eliminated as a factor. Many deaths under anæsthetics have been, without doubt, purely emotional. The suffering woman accepts relief more than willingly; she has no dread of its means. A far stronger element of safety is the slow and gradual administration during labor. The danger of a strong impression of chloroform, and of the rapid inhalation of air highly charged with its vapor, was early pointed out;[3] the warning has been often repeated since, yet many deaths from this cause have occurred, and patients have been exposed to danger in this way, as has been seen, even in obstetrics.

But so few have been the accidents in obstetrical practice, compared with the vast number of patients submitted to anæsthesia both in natural and operative labor, these points alone have not seemed satisfactory, and attempts have been made to find in some condition of the parturient woman a special source of safety. Campbell makes a strong plea for the efforts attending labor as the safeguard. The condition

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from, will give a striking idea of the few cases to be found. Written to present the dangers of chloroform by a gentleman having large hospital and private experience, in order to collect seven cases the author has been obliged to go outside of his own practice, outside of his own city, outside of his own country, and also outside of the profession, for in one of the reported cases administration was by a hospital "sister."

[1] "It may interest you to know that only a few days ago I nearly lost a woman during a difficult breech extraction from ether asphyxia. I never saw any one so nearly dead from an anesthetic recover."—*Letter from an Obstetrician in an Eastern City.*

[2] In Snow's statistics, 3 men to 1 woman; in Scoutteten's, 2 to 1; in Sansom's, 23 to 10; in another collection of 100 cases, 66 men to 34 women.

[3] Warren, Bigelow: *Trans. Am. Med. Assoc.*, vol. i.

of anæsthesia is one of cerebral anæmia; expulsive effort tends to counteract this. But anæsthesia is something more than anæmia of the brain, and effort is exerted during but a small portion of labor. A better argument may be made for the existence of pain as the element of safety. The record of chloroform deaths shows a very large proportion among those about to undergo an operation and during operations of a trifling character. This view has been advanced or maintained in this country by Channing,[1] Byford,[2] and Skene.[3] The experience of army surgery affords strong confirmatory proof of this view. With the weighty element of sex adverse to safety, dealing with strong, muscular subjects—a class well known to be unfavorable to the action of anæsthetics—military surgery has furnished much below its average of deaths in its very large number of administrations. Pain, and severe pain, from the ravages of shot and shell, is present in the great majority of cases anæsthetized in military practice.

A careful study of the subject of accidents from chloroform during parturition justifies the following statements:

1. But one well-authenticated case of death is on record where the administration was by a medical man, and in that case no autopsy was held.

2. Dangerous symptoms have occurred but a very few times, and then almost always from violation of the rules of proper administration.

3. The danger when chloroform is used only to the extent of mitigation or abolition of the suffering of childbirth is practically *nil;* when carried to the surgical degree for obstetric operations, the danger is far below what it is in surgery.

4. No proof can be furnished that the parturient woman enjoys a special immunity from the dangers of anæsthetics, although facts seem to indicate that such exists. Her best safeguard lies in the care and watchfulness of the administrator.

## EFFECT OF CHLOROFORM UPON THE UTERINE CONTRACTIONS.

The influence of chloroform upon the various divisions of the compound process of labor requires attention. At the head of these processes stands the uterine contractions: the prime importance of non-interference of anæsthetics with them was early recognized, and the absence of any deleterious effect upon them was strongly emphasized by the friends of the method. Since then, however, the testimony upon this point has been most diverse. It has been maintained that by chloroform the uterine contractions are not affected, that they are augmented, that they are diminished, and that they are suppressed.

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[1] *Trans. Am. Med. Assoc.*, vol. ii. p. 247.

[2] Beatty's *Contributions*, p. 193.

[3] *Am. Journ. Obstet.*, vii. p. 278.

Authorities of equal standing could be quoted in support of each of these propositions. The first attempt, then, must be to explain such wide differences of opinion based upon observation of facts, and then to render judgment according to the weight of evidence and the character of the observers.

An explanation of the clashing testimony is not difficult in view of the varying circumstances under which, and the individual peculiarities of those to whom, anæsthetics are administered: 1. A temporary cessation of the pains upon commencing inhalation was early observed, and by Simpson, Channing, Siebold, and others was recognized as temporary. It is doubtless largely emotional in origin; a little encouragement and a little time suffice for its disappearance; but there can be no doubt that this has by some observers been considered permanent and caused an adverse judgment of the process. 2. Anæsthesia is much more frequently followed by cessation or diminution of the pains in the early stage of labor than later when reflex actions are powerfully excited by the descending head. 3. The effect upon the pains will vary with the depth to which the anæsthetic effect is carried. This depends upon the progressive and ascending action of the agents on the nervous system. If analgesia alone is caused, the uterine contractions are not interfered with; carried deeper, they are weakened, and in profound narcosis they may be entirely suspended. No one who has attempted a difficult version without and with anæsthetics could doubt their power over the uterine contractions. 4. There can be no doubt as to the existence of marked individual peculiarities in this respect. In certain cases, even with small doses, the pains are so affected by chloroform as to compel its abandonment. Such cases are reported by some of the warmest advocates of the agent. 5. Prolongation of the administration, if carried at all beyond the stage of analgesia, has a tendency to weaken the force of the pains and lengthen the intervals between them. Under these varying circumstances it is not surprising that there has not been harmony of opinion among observers.

Winckel made a careful study of this subject, and his results are often quoted.[1] They are to the effect that chloroform narcosis lengthens the intervals between the pains and shortens the acme of the contractions, and that it therefore increases the duration of labor. Winckel's studies were too limited in number, being confined to two normal and two abnormal cases, to justify generalization. Moreover, it is not just to restrict the inquiry to the stage of "narcosis;" it is very important that it should include the stage of obstetric analgesia.

It is a singular fact that very strong testimony as to non-interference of chloroform with the efficiency of the pains has been rendered by strenuous opponents of its administration in normal labor, and by men

[1] *Verhandl. der Ges. [illegible] Geb.* [illegible] B[illegible] [illegible]

who have observed it carried to the surgical degree for operations, such as severe forceps deliveries and repeated cephalotripsies. Both Depaul and Pajot are positive in statement that chloroform does not exercise any influence upon the uterine contractions.

A careful review of all the testimony, together with an estimate of its value based upon the amount of experience and character of those who render it, leads to the following conclusions, with every one of which the experience of the writer coincides:

1. The action of chloroform upon the uterine contractions may vary according to the period of labor and the peculiarities of the patient, and especially with the degree to which anæsthesia is carried.
2. A temporary diminution or cessation of uterine action is not at all infrequent. Occasionally, however, chloroform permanently abolishes the pains.
3. Obstetric anæsthesia, or analgesia, has no effect, as a general rule, upon the uterine contractions.
4. In surgical anæsthesia the energy, frequency, and duration of the contractions may be, and generally are, lessened: in deep narcosis uterine action is in abeyance.
5. Upon withdrawal of the anæsthetic, and with disappearance of the anæsthetic effect, the uterus promptly resumes its functions.
6. The tendency of the agency is, then, toward causing a diminution of uterine action, and this tendency should be kept constantly in mind by the accoucheur.

### THE INFLUENCE OF CHLOROFORM UPON THE ACTION OF THE ABDOMINAL MUSCLES.

As labor enters upon its expulsive stage the muscles of the abdomen take part in it. Called into action by an influence emanating from the pelvis and reflected from the upper part of the spinal cord, they give energetic assistance. The influence of anæsthetics upon this accessory force has also been doubted, affirmed, and denied. Still, by far the greater amount of testimony is favorable to the non-interference of anæsthetics with their action, while the statement, in general terms, may be the same for these as for the uterus. Longet, at the earliest period of the history of the subject, noted the continuance of the action of these muscles while all others were relaxed, and explained it physiologically. They are accessory muscles of respiration: like those muscles, their action is both voluntary and reflex, and, having their origin near the respiratory centre, anæsthesia must be carried very deeply before they are affected. Clinical experience confirms this. Anæsthesia in its mildest degree does not affect them; as it is deepened, their action is weakened; in profound narcosis it is suspended.

While the abdominal muscles aid in the delivery, and their assistance should not be needlessly prevented, still it is not essential. The uterus itself is entirely competent to effect delivery, as shown by two series of cases: 1st, by those in which delivery has taken place when the uterus is outside the abdomen; 2d, by those in which delivery has occurred *post-mortem*.[1] There are many cases of both these classes on record, and they tend to show that the importance of the aid rendered by the abdominal muscles in parturition has been exaggerated.

UPON THE OS AND CERVIX.—In labor there should be harmony of action between the different portions of the uterus; dilatation of the cervix should occur in due time and in preparation for expulsive effort of the body and fundus. This harmony is often lacking, and the process is delayed by unusual resistance of the os. This abnormal condition has been referred to rigidity, to spasmodic action, and to an induration of tissue resulting from former plastic deposit, and doubtless is dependent, in different cases, upon each. Whatever may be the exact pathological condition, the suffering of this stage of labor is often so severe as urgently to demand relief. The woman is not now sustained and cheered by that assurance of progress which she feels during expulsion, and hours of suffering bring only exhaustion and discouragement. The relaxing and analgesic effects of chloroform peculiarly adapt it for this condition of things. The cervix and os are supplied with nerves from the cerebro-spinal system, and therefore pass early and readily under the influence of the anæsthetic. It is not so certain, however, that relaxation will follow inhalation as amelioration of suffering. If the rigidity depend upon plastic deposits, relaxation will not be effected. Such cases are rare. In those where the os is thin, sharp, resisting, hot, and dry, and sensitive to the touch, chloroform, if administered for a time, often effects a most favorable change. This is the condition for which heroic bleeding was once the approved remedy. Barnes, who is no warm advocate of chloroform, says that it is here "often of signal service."[2] Dutertre claims that to be efficient the anæsthetic must be often pushed beyond the stage of analgesia. This view is sustained by the benefit often resulting when the first stage of labor is tedious from suspension of the pains for a time, the membranes being unruptured, by a full dose of morphia.

Of late years chloroform has been largely superseded by chloral for this condition of things, its action seeming peculiarly adapted to the early stages of labor, while chloroform, if resorted to, may be demanded for too long a time. There are some of these cases, however, in which chloroform renders immediate relief and most efficient service. They are those in which expulsive force is in advance of dilatation. The pains are active and strong, and the os yields passage to the head only from the *vis à tergo*. The woman restrains to her utmost bearing-down effort on account of the horrible suffering. The rapid and efficient action of chloroform peculiarly adapts it for such cases. It often acts like magic. The patient expresses relief in the liveliest manner, brings her voluntary powers to bear, and the duration of labor is decidedly shortened as well as its suffering alleviated.

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[1] Duer: "On Post-mortem Delivery," *Amer. Journ. Obst.*, xii. No. 1.

[2] *Obstetric Med. and Surg.*, p. 744.

UPON THE PERINEUM.—The influence of chloroform in promoting relaxation of the muscles of the perineum has been emphasized from the earliest period of its use, and has been over and over again repeated since. The nerves which excite these muscles to action, having their origin in the lower portion of the spinal cord, necessarily submit early and completely to the anæsthetic. That all resistance of the perineum is abolished when its muscles are paralyzed cannot, of course, be maintained. Much of this depends upon other constituents of this compound structure, as the fibrous and the adipose tissues, as well as the skin. Due consideration of this fact renders a ready explanation of the much greater apparent effect of chloroform upon the perineum of multiparæ than of primiparæ. In the former the aponeuroses have undergone previous distension, and it is at this point in this class of patients that chloroform is often seen to markedly shorten labor.

A very important question must be considered here: Does this relaxation promote, or act as a safeguard to, rupture of the perineum? That lessened resistance of an annular structure will promote the passage of a solid body through it without tearing would seem a self-evident proposition. Yet there are weighty names on the negative side. Johns of Dublin attempted to show that the proportion of ruptures of the perineum is 1 : 93 without chloroform, and 1 : 27 with it. Barnes believes that ruptures are more frequent under anæsthesia.[1] Spiegelberg would seem to favor this view, since he advises cessation of inhalation during extrusion of the child, "because we often need the unclouded conscious assistance of the woman for preservation of the perineum."[2] Cazeaux says that further observations are necessary to determine the question. He relates some cases in which rupture took place under deep anæsthesia, and justly adds: "Perhaps it would be well to remember how variable is the resistance of the perineum in different individuals, and how difficult it is to foresee what will occur in a given case."[3]

Casting aside the intricacies of biological physics, and looking to the most numerous and best authorities, giving, moreover, the lessons of experience, it may be boldly stated that no one thing is more efficient as a preventive of rupture of the perineum than the administration of chloroform. It effects this—1st, by a certain amount of relaxation of the structures; 2d, by preventing those sudden movements of the body made by the woman in the agony of suffering, and by which rupture is often caused; 3d, by lessening, and when carried to the deeper stages by abolishing, expulsive effort, whereby the advance of the head is slowed, time is gained for the tissues to give, and the exit of the head can be effected in the interval rather than at the acme of uterine action.

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[1] Dutertre: *op. cit.*, p. 100.

[2] *Lehrbuch der Geburtshülfe*, p. 194.

[3] *Traité des Accouchements*, neuvième ed., p. 953.

Upon the Duration of Labor.—It will be seen from the foregoing that it is by no means easy to decide whether chloroform lessens or increases the duration of labor. Upon the one hand, anæsthesia tends to weaken the pains and diminish expelling force; upon the other, it regulates, and sometimes increases, the uterine contractions, and by promoting relaxation it diminishes resistance. It is not surprising that authorities should differ widely upon this point as their observation has varied. Some have maintained that "chloroform accelerates labor in a greater number of cases than it retards it."[1] Lusk, again, deems it "certain that those who use chloroform habitually will find themselves compelled to resort to the forceps with somewhat increased frequency"—a proposition which may be accepted if the word "probable" be substituted for "certain." But there is a possible source of fallacy here which should by no means be overlooked. Kucher found the forceps required twice as often on account of deficient contractions of the uterus among the well-to-do of New York as among healthy servants and peasant-girls.[2] Doubtless Snow expressed at an early day the truth of the matter: "Chloroform produces no effect on the duration of labor in the whole number of cases, but individual labors are either accelerated or retarded by it."[3]

In Promoting Hemorrhage after Delivery.—An inquiry as to the influence of chloroform upon the contraction and retraction of the uterus immediately after delivery is closely allied to one as to its effect during labor. That authorities should differ widely upon this point is not surprising when the difficulties are considered which attend a clinical study of it. Hemorrhage is a not infrequent sequel of labor, and it is evident that the *post hoc* and the *propter hoc* are easily confounded. Channing mentions a case of severe post-partum hemorrhage in which he had offered ether, but it had not been taken. The writer has had a similar experience as to chloroform; also a case in which a severe hemorrhage occurred several hours after delivery and after he had left the patient's house, and no anæsthetic had been given. On the other hand, the adduction of cases in which hemorrhage had formerly occurred, and then with an anæsthetic has been absent, are valueless in support of the doctrine which has been held by some, that chloroform lessens the liability to this accident. In order to answer the question as to the influence of anæsthetics in causing post-partum hemorrhage by statistics, an immense collection of cases would be necessary, conducted with and without the agents, and the reports should include the ages of the patients, the number of previous deliveries, the nature and duration of the individual labor, and especially the depth and duration of the anæsthetic influence. No such statistics exist, and a judgment must be formed from the opinions expressed by competent observers. The French school, hostile to chloroform in natural labor, has never brought the charge against it of promoting post-partum hemorrhage, while their observations have been of cases of deep anæsthesia continued for hours.[1] The cautious statement of many authorities not over-favorable to chloroform should also be noted. Blot says:[2] "It has *seemed* to me that the quantity of blood lost immediately after delivery has been somewhat [*un peu plus*] more abundant than usual." Cazeaux gives but a doubting affirmative answer to the question whether chloroform favors hemorrhage.[3] Both Hall Davis[4] and Dr. Edis[5] state their belief that anæsthesia has a *tendency* to favor post-partum hemorrhage. If these expressions are ambiguous, they clearly show that the question is not an easy one even to men of large experience. Dutertre,[6] after a full examination of authorities, sums up by saying: "There is no proof that hemorrhage is more frequent after labors with anæsthetics." Dr. Fordyce Barker has recently devoted a special paper to this subject.[7] He is strongly convinced that chloroform does not promote post-partum hemorrhage. His experience is striking: having administered it in several thousand cases, the only case of hemorrhage met with occurred when the anæsthetic was not given.

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[1] Barker: *Bull. N. Y. Acad. Med.*

[2] *Puerperal Convalescence*, by Jos. Kucher, New York, 1886.

[3] *Am. Journ. Med. Sci.*, Oct., 1853, p. 526.

On the other hand, some late and accepted authorities are of different opinion. Playfair[8] believes that it has "a marked effect in predisposing to post-partum hemorrhage." Lusk[9] says: "It certainly favors the relaxation of the uterus and predisposes to hemorrhage." These statements are made without qualification, and without reference to the degree of anæsthesia; which is a most important point. That effect upon uterine action after delivery should vary with the depth of the anæsthesia, as it does during labor, is as reasonable as it is in accord with experience; and Zweifel[10] we believe is correct when he says that only "when chloroform is inhaled so long and in such quantity that all striated muscular fibre relaxes" is there danger of a post-partum atony. However diverse opinions may be upon this

[1] Pajot: *Dict. encycl.*, art. "Anæsthésie obstétricale."

[2] *Op. cit.*

[3] *Op. cit.*, p. 955.

[4] *Trans. London Obstet. Soc.*, vol. v. p. 137.

[5] *Brit. Med. Journ.*, Nov. 16, 1872.

[6] *Op. cit.*, p. 96.

[7] *Philada. Med. News*, Feb. 12, 1887.

[8] *London Lancet*, Feb. 21, 1874; *System of Midwifery.*

[9] *Trans. Am. Gyn. Soc.*, ii. p. 208.

[10] *Lehrb. der Geburts.*, 1887.

question, the practitioner will do well in practice to bear always in mind the "*tendency*" of the agent he is using.

Upon the Puerperal Condition.—There is no evidence that the administration of chloroform during labor exerts any prejudicial influence upon the puerperal stage. Since a very early period in the history of the method no such charge has been made. The experience of the writer is fully in accord with that of many authorities, who state that patients frequently volunteer testimony as to a more satisfactory condition after having taken the anæsthetic. There is an absence of fatigue and of muscular soreness and lameness almost always experienced after labor.

Upon the Child.—Neither does chloroform exercise any injurious effect upon the child. The question of a possible injurious influence of this agent was lately reopened, when it was established that when chloroform had been inhaled by the mother it could be found in the blood of the child.[1] Hofmeier attributed jaundice of the newborn directly to this, but he is alone in doing so. Zweifel considers the subject at some length,[2] and says distinctly that he has abandoned any belief in this view, "because I could not substantiate a greater frequency or intensity of the icterus than in other children under similar external surroundings." Neither had he seen any bad effect upon the health of the child from the icterus when it did occur.

## Chloroform: Mode of Administration.

A good remedy will fail of its effects if not properly administered. This truism especially applies to anæsthetics, even in surgical practice, while in obstetrics care and skill are essential to the successful use of them, and out of all proportion to the attention bestowed upon the subject in the textbooks. No one can be a good administrator of an agent so powerful as chloroform without a careful study of the chemical, physical, and vital principles concerned. A few of these should be clearly understood. As to the exact nature of the change which it effects in the cells of nervous centres it is needless to inquire. It is sufficient to know that the effect is by a direct action upon these cells, according to all authorities, and that the chemical theory of former times, which referred the action to suspended oxygenation of the blood, has been abandoned. Neither is artificial anæsthesia cerebral anæmia, although this state accompanies it. Chloroform belongs to that class of poisons which have an elective action upon the nervous system, selecting certain parts and leaving others alone. Bernard happily likens anæsthetics to "physiological scalpels," which can separate portions of the system more skilfully than the scalpel of the anatomist.[1] A special affinity to the nervous system is shown by the preponderating amount found in it; thus, when the amount in the blood is 1 part, there will be in the brain, of ether, 3.25, and of chloroform, 3.92 parts.[2]

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[1] *Berlin klin. Wochenschrift*, 1874, No. 21; "Verhand. der Naturförscher in Hamburg, 1876," *Archiv für Gyn.*, Bd. xii. p. 235.

[2] *Handbuch der Geburtshülfe*, 1887.

The rapidity of the action of chloroform is an important fact. Entering the system through the pulmonary circulation, it passes directly, with the blood-current, to the nervous centres. In like manner and with the same rapidity the system clears itself, and cessation of administration ensures speedy cessation of effect. The fact enforces attention to the importance of intermittence of the inhalation. Paul Bert found that dogs in a mixture of air and chloroform vapor which required an hour to produce insensibility invariably died at the end of seven hours. Intermitting administration could be continued indefinitely with safety.[3] The residual air of respiration should also be held in mind by the administrator of chloroform. The cumulative action of this agent, of which a great deal was formerly said, is only the additional effect of the amount of vapor contained in this air; in other words, the effect of chloroform will continue to be progressive after the influx of vapor by the tidal current of respiration has been stopped, until all that is in the air of the lungs and bronchial tubes has passed into the blood. The vapor of all anæsthetic agents is very much heavier than air; and this fact has an important bearing upon the position of the mouth and nose of the patient in relation to the surface from which it is inhaled. Temperature has a powerful influence upon the amount of vapor which air will carry. With a change of the thermometer of 20° the amount of chloroform vapor in the air doubles. Thus at 65° it will take up 15 per cent., and at 85°, 30 per cent. Such differences occur in the ordinary weather of different seasons. The amount carried by the air is also increased by a current. The quantity of chloroform vapor in air which it is safe to administer, 5 per cent. and below, was early worked out by Snow, and the danger of larger amounts clearly shown. While it is not possible for the practitioner to measure percentages of vapor, and while there is a "clinical dose" the measure of which is the effect, the danger of too heavily charged air cannot be over-emphasized. Bert found that dogs remained unaffected for any length of time in air containing 2 grammes of chloroform to each 100 liters; with 10 grammes they became anæsthetized rapidly and died suddenly; with 20 grammes death was by "sideration" and preceded anæsthesia.[4] The record of chloroform accidents shows many cases plainly due to the sudden inspiration of air heavily charged with the vapor.

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[1] Bernard: *op. cit.*, p. 124.

[2] Perrin: *op. cit.*

[3] *Annuaire de Thérapeutique*, Bouchardat, 1884.

[4] *Ibid.*, 1864.

Essential requisites of any apparatus or plan for the safe administration of chloroform are that it shall ensure a thorough admixture of air with the vapor, also give the power of graduating the process and limiting the dose. Nature has prepared an instrument which fully meets these demands. It is a hollow or cup-shaped sponge, the cavity of which will admit the fist and thus cover easily the mouth and nose. This article, dipped in warm water, and squeezed out, is unequalled in convenience and efficiency. It is soft and pliable; it is so porous that the supply of air cannot be shut off; if pressed together after chloroform has been sprinkled on it every little interstice, as it gives passage to air, yields to that air its modicum of vapor. The only device at all comparable with it is Esmarch's mask, and that is not so readily carried. An essential adjunct to this sponge is a bottle which will only permit the escape of the liquid by drops. A perfume-bottle with a screw-cap tube is the best, or an ordinary perforated cork will answer the purpose. Provided with these the administrator has perfect command over the rate of administration, while the mode almost universally recommended and followed of pouring chloroform on a handkerchief or napkin is faulty in the extreme. It is not only faulty, but dangerous. This is not a matter of opinion, but of the facts of physics. The current of inspiration can never be equably charged with the vapor of a liquid which is poured on a cloth in patches, so that it does not pass through, but only over, the moistened surface. The patient cannot fail to get at one breath air only slightly charged with the vapor, and at another that containing a dangerous amount.[1] It is with the utmost confidence that the conviction is expressed that many practitioners have given up the use of chloroform in obstetrics from neglect of attention to these minute points. In every department of medicine there are many *great little* things.

The pain or circumstances of natural labor demanding chloroform, its acceptance or rejection should rest entirely with the patient and her friends. A due regard to his own interests should restrain the practitioner from doing more than to offer the means of alleviation. Before proceeding to the administration the condition of the heart should be ascertained. Then the accoucheur will do well to advise the patient that the object is relief rather than abolition of suffering; also, that the effort will be tentative at first, and that its continuance must depend upon the effects. This is especially necessary in the early period of labor. Then, sprinkling a few drops of the liquid on the sponge and squeezing it together, it is applied to the patient's mouth and nose. If coughing is excited, the vapor is altogether too strong. If the pains lessen in force or cease, a few words of encouragement, a little delay, and recommencement with a very small dose will generally obviate the difficulty. When the patient shows that she is passing under the influence by expressions of relief, the sponge is withdrawn, replenished, and held closed in a folded towel to prevent evaporation. The patient will indicate, if told to do so, when a pain is approaching; then two or three deep inspirations will anticipate the suffering. The object is to keep her in the first stage of anæsthesia of authorities. These are three by Sansom: 1, sopor; 2, stupor; 3, stertor.[1] But Campbell divides this first stage again into three: 1, an initial period of simple amelioration; 2, incomplete analgesia; 3, complete analgesia. But the different degrees of narcotism glide insensibly into each other. The distinction of stages which Snow makes is a good practical one. In the first the patient retains a perfect consciousness of where she is and what is occurring around her; in the second there is no longer correct consciousness.[2] The respiration of the patient and the appearance of her countenance indicate her condition. In obstetric analgesia, and with a small amount poured on the sponge, there is no need of watching the pulse. After the patient has ceased to make voluntary remarks a question will enable the administrator to judge of the extent of the influence by the readiness and coherency of the answer. A better description of this process has never been given than that by Channing:[3]

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[1] "Nothing is more simple than the compress, but nothing is worse; its employment is the inversion of all scientific precision."—PAUL BERT.

"The object in ordinary midwifery practice, or in the severer forms of labor-pains, in the use of etherization[4] is to *diminish* suffering. There is much of this pain which is tolerated readily, and from this the patient does not demand relief from extraordinary agents. So true is this in practice that cases daily occur in which etherization is induced, and in which the patient determines exactly its extent. In the intervals of uterine contractions the instrument is removed by the patient or by her direction given in some way, and which is at once understood. She knows when the pain is coming and demands the inhaler. She graduates, so to speak, the supply exactly by the demand; and in this way is presented to the observation of the practitioner one of the most important and interesting agencies in operation for relieving suffering, sometimes agony, which he ever notices."

As the head distends the vulva the effect of chloroform is carried more deeply to meet the acuter suffering of this stage. Full surgical anæsthesia may be required, and is often necessary, as an efficient aid in delivery of the head without injury to the perineum. The head being delivered, the administration should cease.

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[1] *On Chloroform*, London, 1865.

[2] *Op. cit.*, pp. 35, 37.

[3] *Op. cit.*, p. 74.

[4] It will be remembered that Channing applies this term to the effects of chloroform as well as ether.

No assistant is necessary for the administration in ordinary labor. This is evident during the greater portion of labor, when an examination is only occasionally needed. But toward the close of the process, when the exit of the child requires the constant application of one hand, the accoucheur can still conduct the process himself with a little management. If the patient is in the dorsal position, she has only to be brought close to the edge of the bed to enable the accoucheur to reach her face with one hand while the other supports the perineum. In the English position, if the hips are brought close to the edge of the bed, the patient lying diagonally across it, the practitioner from behind can also control both processes. The necessity for these minute directions has been more than once made evident to the writer.

The length of time during which the inhalation of chloroform may be continued would be difficult to determine. Paul Bert's experiments have indicated its harmlessness with small doses and an intermittent administration. In practice Snow has continued it for thirty-one hours,[1] Simpson fourteen hours, Protheroe Smith twenty-eight hours. Aubenas[2] gave it during eighteen hours for a case of convulsions, and saved both mother and child. All these have been surpassed outside the domain of obstetrics. Brown-Séquard in a case of periodically returning epilepsy kept a patient under the influence of chloroform during seven consecutive days. The attack was warded off and the patient had no more for two years. The case was reported to show "that it is possible to keep a patient under the influence of chloroform a very long time."[3] Snow is undoubtedly correct in saying that "the quantity of chloroform given in labor might be continued daily for an indefinite period without appreciable effect on the health."[4]

It is evident from the foregoing that the administration of chloroform in labor is no light or easy task. It is too serious a matter not to be done well; to do it well requires great care, close attention, constant watchfulness, and entails no small amount of extra fatigue.

FOR OBSTETRICAL OPERATIONS.—The administration of anæsthetics for the operations of obstetrics is surgical anæsthesia. Its benefits here have never been called in question, a resort to it whenever indicated never opposed. The methods of the one process are exactly the same as those of the other, and only in one point do they seem to differ. That point has already been alluded to—the marked absence of accident in obstetric practice. No operations of surgery are more severe than turning in neglected cases, high-forceps operations, or repeated cephalotripsies. None require deeper or more prolonged anæsthesia. Yet the absence of accident is almost complete, and so large has been the happy experience that the explanation seems forced of a special immunity on the part of the pregnant woman.[1]

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[1] *Op. cit.*, p. 323. [2] French translation of Naegele and Genser, 1880, p. 786.

[3] *Annuaire de Thérap.*, Bouchardat, 1884, p. 33.

[4] *Am. Journ. Med. Sci.*, Oct., 1853, p. 526.

Under chloroform the operation of version is very much facilitated and rendered possible in cases which without it would be impracticable. Indeed, it was in cases of neglected cross-positions that anæsthetics won their earliest and most brilliant triumphs. The most determined opponents of their use have testified to their benefits in such cases, and experienced accoucheurs have succeeded in turning under chloroform when all previous efforts had failed and all preparations had been made for embryotomy.[2] In 17 cases of obstructed labor in women who had previously had craniotomy or embryotomy performed, version under chloroform gave 9 living children and 7 more with heart-pulsation.[3]

In proceeding to administer chloroform for version the obstetrician should be fully alive to the fact that anæsthesia must be carried very deeply. All voluntary effort must be rendered impossible; even in the deepest narcosis, as manifested by stertorous respiration, the introduction of the hand will not always fail to excite uterine contractions. "In animals contractions of the uterus continue during the deepest anæsthesia, and persist even after they have ceased in the heart."[4] An assistant is most desirable in these cases, and should always be obtained if possible. Still, a neglected shoulder presentation at night, many miles from professional assistance, and urgently demanding relief, may present itself to any practitioner at any time. A few directions may aid in meeting the exigencies of such a case. See to the placing of such assistants as may be at command, and explain what will be required of them. Place the patient in proper position, across the bed, the hips free of the edge, and take measures for her being kept there. Carry the anæsthetic deeply, and do not attempt the operation until there is stertorous, or at least heavy, breathing. In committing the continuance of the administration to a non-professional person the drop-tube is a valuable resource; directions to vigorously shake the bottle will be necessary in order to get out enough of the liquid; an over-dose is not easy, and with the patient on her back the accoucheur has full view of her countenance and can watch the respiration. The imagination has not been drawn upon for such cases, and experience has taught the dependence of success upon attention to details. Just here have been furnished some of the most striking instances of the benefits of anæsthesia, and the number of lives saved by it in this class of cases will never be known.[1]

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[1] Perrin: "Proc. Soc. de Chir.," *Union Méd.*, Oct. 10, 1876.

[2] Hall Davis: *Trans. London Obstet. Soc.*, v. p. 137.

[3] Kidd: *Med. Times and Gaz.*, July 4, 1863.

[4] Fredet: *op. cit.*

In administering chloroform for forceps operations the question was formerly much agitated whether the instrument should be applied before anæsthesia was induced or afterward. The objection formerly made, that in the latter case the patient could not indicate hurting by the instrument, is trivial. Either course may be pursued, but the former seems in every way preferable, and has always been pursued by the writer. As traction is made, or in anticipation of it, the inhalation should be commenced. Assistance is desirable even in the practitioner's interests; in severe cases it is indispensable. Still, many forceps cases have been and may be conducted, and chloroform administered, without aid. The operator has the same control of the patient and command of the process as in version. With experience such cases can be managed very well when circumstances do not permit of assistance.

INDICATIONS.—Chloroform being given in labor as an analgesic, pain is the indication for its employment. But while there is no labor without pain, it is not every labor which requires chloroform. In muscular women of the lower classes labor frequently causes more effort than suffering. In women of nervous type, whose systems have been enervated by refinement and luxury, the suffering is apt to be acute. In all classes there are some happy exceptions in whom parturition proceeds rapidly and the pain is not severe enough to tax the nervous system and is well borne. The necessity or advisability of chloroform to facilitate labor must rest with the obstetrician; as a means of relieving pain it should depend upon the patient. If she demand it, there is no reasonable ground for a denial.

There are other indications besides pain for the use of the remedy, chief among which is a deviation of the pains from the normal type. Not infrequently they are spasmodic in character, irregular as to recurrence, and doubtless affect but a portion of the uterus. In such cases chloroform has often a most happy influence, bringing harmony out of discord, restoring the normal, and evidently shortening the duration of labor. If irregularity be a marked feature, the os being but little open and the waters not discharged, a good dose of morphia will probably be best, and there is no doubt that chloral may often be used to better advantage than chloroform in the early stages. Still, the statement above made rests upon experience as well as abundant authority. Sometimes the pains deviate from the normal by being more than usually severe, and they follow each other closely. In these cases chloroform gives the most marked and certain relief. The type of a labor which best shows the benefits of anæsthesia is one in which expulsive power is active and in excess of dilatation, in which the head is crowded through parts not yet prepared for its passage. Carried deeply enough to moderate the violence of these abnormal contractions, chloroform here renders brilliant service.

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[1] In the village where the writer began professional life, before anæsthetics were much used, two women died undelivered, with shoulder presentation, within four years. He saw but one of the cases, and that only just before death.

Certain conditions of the general nervous system demand chloroform. Some patients are nervous and hysterical, controlled with difficulty, and the commencement of labor is marked by a very considerable excitement. This abnormal condition is soon soothed and quieted down by the administration of an anæsthetic.

There is a general agreement of authorities that the best time for commencing administration is when the os is nearly opened and expulsive pains are about to begin. Whether anæsthesia has been needed earlier or not, it will very likely be demanded now. The most painful periods of labor are when the head distends to the utmost and clears the two resisting circles of soft parts, the os and the vulva. During that part of the process in which the head is moulded to the bony canal, which sometimes requires many pains, the anæsthetic effect is not so much needed, and chloroform may often be dispensed with. The stretching of soft parts, however, is often agonizing, and at the vulva relief is most urgently called for. At this period the anæsthesia may, and often must, be carried to the surgical degree. With entire unconsciousness and complete acinesia not only is acute suffering saved, but delivery of the head is effected with less danger to the integrity of the perineum than under any other circumstances.

The head having been delivered, the administration should immediately cease. The third stage of labor does not demand it. The only question as to anæsthesia during this period is whether it is justifiable or advisable to resort to it for manual delivery of the placenta in cases of irregular or "hour-glass" contraction of the uterus. In some of these cases the constriction is close, at once difficult and painful to pass with the hand. There seems no good reason why suffering should not be saved here as well as elsewhere, and the relaxing as well as the analgesic effect of chloroform utilized. For this complication of labor it was used the first time by Snow, and numerous authorities advise its use in these circumstances and testify to its efficiency and safety. It should be said, however, that the high authority of Lusk is on the opposite side. He is very positive as to the danger of chloroform in the third stage of labor.[1] The single case reported by him was one of severe, prolonged, and complicated labor, and as the death took place "some hours" after the administration ceased, the anæsthetic was, in all probability, but a minor factor in causing it. The writer has given chloroform a number of times for removal of a placenta retained by irregular contraction, and should not hesitate to do so again. A dose of ergot should always precede the administration in these cases, and, indeed, whenever chloroform has been given deeply or for a considerable period of time. In the early days of obstetric anæsthesia the conjoint use of ergot and chloroform was very common. Now, however, the oxytocic is rarely if ever given before the birth of the child, but its administration just after delivery to antagonize any relaxing effect which chloroform may have is good practice.

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[1] *Trans. Am. Gyn. Soc.*, vol. ii.

CONTRAINDICATIONS.—It may be stated, in general terms, that no contraindications exist to the administration of chloroform in labor when the severity of the pain demands it. Diseases of the vital organs and some special conditions, however, demand careful consideration. In cases of disease of the brain, heart, or lungs the same general principles must guide the obstetrician as the surgeon. Organic disease of the brain is met with very rarely in parturient patients. The functional neuroses are no bar to the administration of anæsthetics. Chloroform is one of the best remedies for any hysterical symptoms which may occur in labor. Some severe outbreaks witnessed by the writer during inhalation for surgical operation have yielded speedily to steady continuance of the administration. Occasionally an epileptic attack is brought on by inhaling chloroform in subjects of the disease. The well-known value of this agent in puerperal convulsions, the experience of Snow, who has "many times administered it to epileptics for operations without exciting a fit,"[1] and the experience of Brown-Séquard in preventing attacks, already given, furnish satisfactory evidence that an epileptic patient in labor is better off with chloroform than without. Hysteria is most likely to occur in the earlier stages of administration; epilepsy, on the contrary, in the later.

Advanced disease of the lungs will not often be seen in connection with labor. In surgery chloroform has been administered to patients suffering from phthisis, even in the last stages, and in those who have had attacks of hæmoptysis without ill effects.[2] Very few instances of the complication are to be found. The following show what has been done:

"M. Lucas Championnière has given chloroform during four hours to a woman suffering from tubercular lesions for some time, and who was breathing badly. The result was so satisfactory that the woman begged for the chloroform after delivery: she was gratified for more than an hour. In another case, where cavities of considerable size had been diagnosticated, and in which the temperature was 39° [102.2 F.], anæsthesia continued for two hours gave results not less favorable."[3]

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[1] *Op. cit.*, p. 52.

[2] Snow: *op. cit.*, p. 53; Dr. A. K. Gardner, *Bull. N. Y. Acad. Med.*, vol. i. p. 312.

[3] Dutertre: *op. cit.*, p. 281.

Diseases of the heart are of especial interest in this connection on account of their not infrequent occurrence in parturient women and from the known influence of chloroform upon this organ. Snow worked out the surgical aspects of the question, and his experience and conclusions have guided surgeons ever since. They may be briefly stated to be, that fatty degeneration of the heart alone should forbid the administration of chloroform, and the diagnosis of this can only be presumptive—that even when this is present in a patient having to undergo a severe operation there is less danger with chloroform than without. In all forms of valvular disease chloroform, "when carefully administered, causes less disturbance of the heart and circulation than does severe pain."[1] The details of cases given fully sustain this opinion.

While actual experience of the administration of chloroform in labor complicated with heart disease is not abundant, all that can be found justifies the statement that in obstetrics the same principles should govern as in surgery. The opinion of all who have studied this portion of the subject coincides. Thus, M. Lucas Championnière says: "If I recognized an organic affection of the heart without pulmonary complications, I should rather give the woman chloroform than to let her suffer." Vergeley of Bordeaux wrote upon this subject, and his conclusion was that "diseases of the heart are not a contraindication to the use of anæsthetics."[2] The most complete study of the question has been made by Dr. Angus Macdonald,[3] and in his book will be found the physiological argument showing how straining and effort are peculiarly dangerous in cardiac affections. But his conclusions, drawn from practice, are better than reasoning: "In almost all the cases [of heart disease with labor] I have met with, chloroform has been given, and apparently with benefit, during delivery. If carefully administered I think it cannot but be useful in all cases."

The following is a striking case: "Mrs. M—— has insufficiency of the aortic valve. Has had six children; the first three were born before she came under my care. In her fourth confinement I was afraid to administer chloroform, because I then shared the popular professional opinion that chloroform ought not to be given when there was organic cardiac disease. My patient fainted several times, and filled me with serious apprehensions for her safety. I then learned that she had experienced the same dangers in each of her previous confinements. In her fifth and sixth confinements I administered chloroform with the most gratifying results. Labor was accomplished without fainting, and her convalescence was extremely satisfactory. My experience in this and other cases satisfies me that a patient laboring under organic disease of the heart will pass through her confinement with greater safety when chloroform is used than when it is not used."[1]

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[1] Snow: *op. cit.*, pp. 54, 57.

[2] Dutertre: *op. cit.*, p. 278.

[3] *The Bearings of Chronic Disease of the Heart upon Pregnancy, Parturition, and Childbirth*, London, 1878.

Dr. Fordyce Barker states it as his opinion that disease of the heart, lungs, and kidneys is an additional reason for resorting to anæsthesia in midwifery, as the vital forces during labor were saved rather than exhausted by the anæsthetic.[2] In his latest communication upon the subject[3] he gives a graphic description of a case of cardiac disease with labor in which the inhalation of chloroform not only gave decided relief, but banished very threatening symptoms. The pulse, which had been very weak and irregular, with a pallid countenance and very bad appearance, became under the anæsthetic regular and stronger, and the dangerous appearance passed away. Since then he has seen several cases in which labor was dangerously complicated with heart troubles, and which terminated favorably, in his opinion, solely from the use of chloroform.

Parvin says that disease of the heart does not necessarily contraindicate anæsthesia in labor.[4]

Dr. Elliot gave ether in a case of labor with mitral regurgitation for delivery with the forceps, and chloroform in another of premature labor where the patient had a loud systolic murmur.[5] He would use ether in these cases rather than chloroform, "in obedience to the general voice of the profession, rather than from any belief that there is more danger in obstetrics from one agent than from the other." He is also certain from his records that he has given chloroform with safety in cases where the microscope afterward proved that fatty degeneration was present.[6]

Dr. A. K. Gardner also administered chloroform in cases of fatty degeneration and of valvular disease of the heart.[7]

There are few points connected with anæsthetics upon which testimony is more unanimous than as to their beneficial effects in labor complicated with heart disease. It is apparent that the practitioner into whose care these perilous cases fall should fully explain to the patient's friends the facts, possibilities, and necessities of the case, and that in the administration of the anæsthetic he should proceed with the utmost caution.

Diseases of the kidneys accompanied by albuminuria are no contraindication to the use of chloroform. It is not only a leading remedy in puerperal convulsions, but renders efficient service in warding off attacks. Kidney disease is, however, a distinct contraindication to the use of ether. The danger from it when these organs are affected was first pointed out by Emmett.

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[1] P. C. Williams, M. D., *Obstet. Journ. Gt. Brit. and Ireland*, vol. vi. No. 6, Supplement (from *Trans. Med. and Chir. Faculty of Maryland*, 1878).

[2] *Bull. N. Y. Acad. Med.*, vol. i. p. 354.

[3] *Medical News*, Feb. 12, 1887.

[4] *Science and Art of Obstetrics*, 1886.

[5] *Bull. N. Y. Acad. Med.*, vol. i. pp. 295, 299.

[6] *Obstetric Clinic*, p. 68.

[7] *Bull. N. Y. Acad. Med.*, vol. i. p. 312.

A condition of acute anæmia produced by large losses of blood is one in which the administration of chloroform is dangerous, and such a condition is a contraindication which should prevent its administration unless under pressing necessity. Bert found that animals from whom blood had been freely taken succumbed to chloroform much more readily than others, and died more frequently. There have been several cases of dangerous symptoms when chloroform has been resorted to in cases of placenta prævia. It is probable that an explanation of the possible danger may be found wholly in physics. With comparatively empty blood-vessels absorption is extremely rapid from every source. Under these circumstances a larger quantity of vapor passes into the system in a given space of time. Should an anæsthetic be called for under these circumstances, ether would doubtless be the safer, or at least the alcohol-chloroform-ether mixture would be preferable to chloroform.

In the early history of obstetric anæsthesia its adherents were compelled to meet the charge that insanity was caused by it. Until time gave experience it was difficult to prove the falsity of the charge. Puerperal insanity, like hemorrhage, had always occurred after labor in a certain proportion of cases, and might be attributed to anything done or left undone. Attention has, then, been directed to this point, and long and careful observation has failed to show any relation between the administration of anæsthetics and the occurrence of insanity after labor. All authorities are in agreement upon this point. Recently, however, attention has been again directed to the influence of anæsthetics in causing insanity. In an address to the psychological section of the British Medical Association in 1884, Dr. George H. Savage said: "Recently I have seen two persons, who were sane when put under chloroform, awake maniacal and remain insane for weeks." Again, in 1887, before the same section of the same society, the same gentleman read a paper on "Insanity following the Use of Anæsthetics."[1] After stating that anything which caused delirium, such as fever, alcoholism, belladonna, might reawaken insanity in one who had already suffered from it, he says: "Chloroform given to a patient recovering from mania might redevelop his mania. Chloroform given to a patient recovered for two years started a fresh attack of mania. An old man who was operated upon under ether remained in a silly, demented state for some weeks, and recovered as suddenly as he became ill. A lady of neurotic type developed acute delirious mania after the administration of nitrous oxide."

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[1] *Brit. Med. Journ.*, Sept. 3, 1887, p. 507. Published in full in the same journal, Dec. 3, 1887.

The debate upon this paper, conducted by the best alienists of Great Britain, developed very little support to Dr. Savage's views and furnished very few facts. Dr. Fiske had seen a case of insanity after taking nitrous oxide when it was fashionable to do so, and the patient remained insane all his life. Dr. Ashe had known a case in which "puerperal insanity had occurred in a primipara, chloroform not having been given; whereas in several subsequent confinements chloroform had been used to a considerable extent, but the puerperal insanity had never again made its appearance." Dr. Savage also made the admission that "after some cases of labor without special complication, in which chloroform was given, insanity had occurred, though other deliveries before and after had been free from any such complication. In most of his cases inherited or acquired neurosis was present."

While no testimony has been adduced to show that the administration of anæsthetics increases the occurrence of puerperal insanity, the possibility of an etiological relation between the two, especially in neurotic subjects, should be borne in mind by the obstetrician, and it would be well to consider a previous attack of insanity as a contraindication to the administration of chloroform as an analgesic.

## CHLORAL.

The physiological effects of chloral are strikingly similar to those of chloroform. Locally, it is an active irritant; in strong solutions vesicant, or even escharotic. It is also decidedly antiseptic. Taken internally, its first effect is a local one on the stomach; then follows a stage of exhilaration similar to that caused by alcoholic drinks; after this comes sleep, and then narcotism. Its action may be divided into three periods: 1, excitement; 2, hypnotism; 3, stupor. Preceding or attending the second and third stages, it exerts a decided anæsthetic action, very much diminishing any pain which may be present, but scarcely ever abolishing it. Chloral causes also marked muscular relaxation, reduces the temperature, and enfeebles the contractions of the heart. It is introduced into the system by the *primæ viæ*, differing in this respect from chloroform, and differing from that agent also in its effect upon the conjunctiva, producing insensibility of that membrane long before that of the skin is affected—"an unique exception, thus far, in the history of intoxications." In poisonous doses death is by cessation of the heart's action, the ventricles enormously distended, and the evidences of gastritis present.[1]

So similar are the physiological effects of chloroform and chloral that Liebreich, the introducer of the latter to therapeutics, formulated a chemical theory of its action, according to which chloral undergoes decomposition in the blood; chloroform is liberated and becomes the efficient agent. The theory has not been accepted. Eminent men have declared themselves in favor of Liebreich's views,[1] while others equally eminent have maintained that chloral produces its effects in its original form: "chemists and vivisectors on one side, *cliniciens* on the other."[2]

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[1] Gubler: *Commentaires thérapeutiques*, 3d ed., 1884, p. 614.

Chloral was introduced to therapeutics in 1869. In the same year it was first used in obstetrics by Simpson, who found that while the patient was so deeply hypnotized by it as to be only partially aware that labor was going on, the uterus still continued to contract strongly and regularly.[3] Lambert of Edinburgh followed with a very full report of 11 cases, and conclusions on the action of the remedy derived therefrom, to which very little need be added at this day.[4] DaCunha also reported 3 cases well illustrating its beneficial effects.[5] In 1874, Dr. Playfair presented the claims of chloral to the profession, and has ever since been a strong advocate of its use. He urged its especial value in women of a highly-organized nervous type, primiparæ, and in whom dilatation of the os took place slowly and painfully. In such cases dilatation was promoted and relief rendered without the disadvantage of suspending labor, as is the case when morphia is administered.[6]

Pelissier presented some experience with the remedy in the same year,[7] and two years later published quite an elaborate paper.[8] He bore witness to the value of chloral in great sensitiveness and rigidity of the cervix, and to its power to calm suffering. His conclusion was that "if chloral lessens the pains of parturition, it acts at the same time on muscular structure, the action of which is first slowed, then arrested. It may be used to moderate excessive sensibility, but should not be resorted to in natural labor." Of 18 cases, 5 demanded the forceps. An explanation of his facts and his judgment may probably be found in the dose administered. This was always from two to three grammes, and in four cases the amount given reached seven grammes.

Chouppe's experience seems to have been as large as Pelissier's, but differed entirely as to the effect of the remedy on the uterine contractions. At the same time he counselled doses large enough to ensure effects, amounting sometimes to four or six grammes. He stated positively that the uterine contractions lose nothing in force or frequency by its anæsthetic action, while it was especially beneficial in hysterical and excitable women who had lost strength and courage by the suffering and duration of the first stage of labor.[1]

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[1] Richardson: *Med. Times and Gaz.*, Nov. 6, 1869.

[2] Gubler: *op. cit.* The student will find here the authorities on each side of the question and the chemical and clinical reasons for rejection of Liebreich's theory.

[3] *Med. Times and Gaz.*, Jan. 1, 1870, p. 4.

[4] *Edin. Med. Journ.*, Aug., 1870.

[5] *London Lancet*, Sept. 24, 1870.

[6] *Ibid.*, Feb. 21, 1874.

[7] *Le Progrès médical*, May 9, 1874.

[8] *L'Union médicale*, April 15, 1876.

Chiarleoni of Milan gave in 1875 the results of his administration of chloral. He had found it particularly useful in nervous, intractable, or discouraged patients, efficacious in relieving pain, not interfering with uterine contractions, and having no deleterious effect upon mother or child. He also showed the value of the remedy in the treatment or warding off of puerperal convulsions.[2]

In this country the first case reported of the use of chloral in labor was by DuHamel, and occurred in September, 1870.[3] Another case took place under the care of Dr. Chapman of Maryland in November, 1874,[4] and a paper appeared soon after by Dr. Prentiss of Missouri giving the results of his experience with the remedy.[5] He had found it soothing to the nervous system of patients, while it ameliorated suffering, promoted relaxation of the os, and shortened the duration of labor. Prof. Richardson of Boston during the same year gave the results of his observation in the Lying-in Hospital.[6] He reported beneficial effects of chloral in the obstinate vomiting of pregnancy, in labor, and in puerperal convulsions. Dr. Frazier of Illinois strongly recommended it to the profession, based upón his own experience.[7] An elaborate paper appeared in 1881 from the pen of Dr. Kane of New York, in which are given the opinions and experience of a large number of practitioners of this country.[8]

A careful survey of the authorities upon the use of chloral in labor shows a striking absence of that disagreement as to facts regarding its action which is the case with chloroform. Interference with the process of parturition was no longer a novel thing when chloral came under observation; moreover, the effect of chloral does not vary so widely with the dose, and especially it does not vary so rapidly as with chloroform. Whatever the explanation, there is a general unanimity of testimony as to the effect of chloral upon the various elements and processes of parturition.

1. It is a quieter of nervous agitation, a stimulant for mental despondency, a soother of irritability, and a tolerably efficient remedy for hysterical manifestations.

2. Its anæsthetic power is decided and considerable. Nevertheless, it cannot rival chloroform in its absolute power over pain. The sufferings of labor are lessened, but unconscious delivery can scarcely take

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[1] *Annales de Gynécologie*, 1875; *Am. Journ. Med. Sci.*, Oct, 1875, p. 562.

[2] *Am. Journ. Med. Sci.*, July, 1875, p. 271, from *Med. Times and Gaz.*

[3] *Am. Journ. Med. Sci.*, Oct., 1870, p. 574.

[4] *Ibid.*, July, 1875, p. 278.

[5] *Ibid.*, Jan., 1876, p. 298

[6] *Trans. Am. Gyn. Soc.*, vol. i.

[7] *Am. Journ. Obstet.*, ix. p. 402.

[8] *Ibid.*, xiv. No. 2.

place. It has not succeeded in establishing itself in surgery as an anæsthetic.

3. Its effect upon uterine contractions is, like chloroform, regulating and tending to restore them to the normal type when they are spasmodic or irregular. In such cases it may seem to increase uterine action. Pelissier, as already shown, stated that it diminished the pains; and Pinard, from clinical study, believes that it enfeebles rather than reinforces them;[1] but all other observers agree that uterine action is not lessened by chloral.

4. The strongest and most abundant testimony is in regard to the influence of chloral in promoting dilatation of the os. It seems specially adapted for cases of thin and rigid os, when the pains are more irritating than effective.

5. Muscular relaxation being a pronounced physiological effect of chloral, it would be expected to promote the passage of the head over the perineum. There is a singular absence of testimony upon this point. Labbé, a very high authority, says that its promotion of relaxation of the perineum is not proven.[2]

The period of labor and the class of cases best adapted to the action of chloral are evident from what has preceded. Its anæsthetic and relaxing effects make it especially useful in the earlier stages of labor, and in primiparæ with whom dilatation takes place slowly. In cases in which dilatation is slow or unusually painful, in which the pains are irregular or spasmodic, the benefits of this anæsthetic are as incontestable as advantageous. For the concluding portion of labor, however, when expulsive power is active, and especially for the passage of the head through the vulva, chloroform is preferable, as the surgical degree of anæsthesia is often required.[3] The administration of chloral does not interfere with the use of chloroform at a later stage.

In giving chloral its irritating qualities must be kept in mind. Administered by the stomach, it should be well diluted; if by the rectum, the vehicle should be bland. Fifteen grains, or one gramme, may be given in an ounce of water, and repeated in twenty minutes, and again in forty minutes if necessary. By enema a scruple to half a drachm may be administered in a mixture of milk and yolk of egg or in mucilage of slippery elm. Gubler says that chloral in suppositories will speedily cause irritation of the rectum. In repeating the doses of chloral the fact should be borne in mind that once given its action has passed beyond control; it presents in this respect a marked contrast to chloroform, with which cessation of inhalation causes very speedy cessation of effects. Chloral is perfectly safe, however, with reasonable care.

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[1] Gubler: *op. cit.*, p. 625.

[2] *Dict. encyc.*, 1e Series, t. xvi., art. "Chloral."

[3] Charpentier: *Traité pratique des Accouchements*, t. i. p. 476, Paris, 1883.

While death has resulted from a dose of one drachm,[1] enormous quantities have been taken and followed by recovery, even six hundred grains.[2]

But one case of death is known to have occurred from chloral in obstetric practice. The patient was a multipara, stout and healthy; labor at seven and a half months. Fifteen grains were given every fifteen minutes, repeated four times, then twenty grains after fifteen minutes more, making eighty grains in seventy-five minutes. Deep narcotism, with stertorous breathing and feeble pulse, followed. Seven hours afterward respirations five per minute, and five hours later still temperature 103° Fahr. Delivery of dead child about eighteen hours after administration of the chloral. Death about twenty-four hours after delivery, consciousness having been partially regained. The exceedingly infrequent respiration and the temperature seem to indicate that death was not caused alone by the chloral.[3]

The contraindications to the use of chloral are the existence of diseases of the stomach and of the heart. The former would certainly be aggravated, and in the latter chloral is decidedly dangerous. In all organic affections of the heart it should not be administered, and Gubler counsels abstaining from it even in functional diseases. So marked is the injurious effect of chloral in this class of cases that the practitioner should always inform himself of the condition of the organ before resorting to it.

## BROMIDE OF ETHYL.

The history of bromide of ethyl as a surgical anæsthetic is a checkered one. Used first by Nunnely of Leeds in 1849, and championed by him before the British Medical Association in 1865 with a very considerable experience, it was not accepted and was soon forgotten. In 1879 it was again brought before the British Medical Association by Dr. Turnbull of Philadelphia, who was not aware of Nunnely's former use of it. Its claims were also advocated by him in this country,[4] and by Dr. Levis, also of Philadelphia.[5] Dr. Connor of Cincinnati published 7 cases with satisfactory results.[6] Based upon these favorable reports, it began to be considerably used until the occurrence of two deaths from it checked its progress, and the publication of H. C. Wood's experiments upon dogs with it[7] may be said to have given it the *coup-de-grâce*. Nevertheless, its use as an anæsthetic in surgery was again revived by Dr. Chisholm[1] of Baltimore and by Dr. Prince of Illinois.[2]

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[1] *Brit. Med. Journ.*, March 8, 1884.

[2] *Am. Journ. Med. Sci.*, April, 1871, p. 595.

[3] Full report of the case in Dr. Kane's paper, *Am. Journ. Obstet.*, vol. xiv.

[4] *Philada. Med. and Surg. Reporter*, March 6, 1880.

[5] *Philada. Med. Times*, Jan. 17, 1880.

[6] *Lancet and Clinic*, April, 1880.

[7] *Philada. Med. Times*, April 24, 1880.

[8] *Brit. Med. Journ.*, March 1, 1884.

In obstetrics bromide of ethyl was first used by Dr. Turnbull and Dr. H. Augustus Wilson of Philadelphia in 1880.[3] In 1882, Lebert published details of 4 cases in which he had administered it—one case of version, one forceps delivery, and two normal labors—and noted the suddenness of its effects and the rapidity of their disappearance. Further experience was published by Wiedemann and Müller. This experience was presented to the profession of this country by Dr. Montgomery of Philadelphia, who in an elaborate paper ably advocated this anæsthetic in obstetrics, and presented his own experience of 29 cases, and that of others, amounting in all to 112 cases.[4]

The action of bromide of ethyl when inhaled is exceedingly rapid; its effects pass off with equal rapidity, and it is very pleasant. In all these points it exceeds even chloroform. These characteristics admirably fit it for obstetric practice, and for labor it would be the anæsthetic *par excellence* if safe. That it is not safe is the most positive conviction of the writer. This conviction is based on—1. Experiment with animals: Wood found a marked depressing effect upon the circulation; Berger saw animals die under its influence "with a rapidity never seen with any other anæsthetic."[5] 2. Experience: the number of deaths from it show an enormous mortality compared with ether and chloroform when the relative number of administrations is considered. 3. Personal trial: the writer inhaled it three times to complete unconsciousness, and while he can testify to its pleasantness, its wonderful rapidity of action, and like rapidity of recovery, the action of the heart showed such perturbations under its influence that he could never decide to administer this anæsthetic or counsel others to do so.[6]

## COCAINE.

The anæsthetic powers of cocaine have been tried to mitigate the pains of labor. Doléris of Paris was the first to publish his observations in January, 1885. Of 9 cases, very considerable relief was afforded in 6 by the application of a 4 per cent. solution to the vulva and vagina. He was followed by Dables and others. Since then the local effects of cocaine have been tried by a number of practitioners. They differ widely. Some have believed that they found very decided amelioration of suffering;[1] others have obtained only negative results;[2] and others, again, deny all influence to the agent.[3] The results seem to differ in the hands of the same person. Thus, Fischel reports of 5 cases, 1 painless, 2 alleviated, and 2 without effect.[4] One observer, who reported "considerable mitigation of pain" with a 12 per cent. solution, afterward found equally good effects from a 4 per cent.[5]

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[1] *Maryland Med. Journ.*, Dec. 5, 1880; *Philada. Med. News*, Jan. 27, 1883.

[2] *St. Louis Med. Journ.*, 1883.

[3] *Am. Journ. Obst.*, vol. xviii. p. 1217.

[4] *Ibid.*, vol. xviii. p. 561.

[5] *Brit. Med. Journ.*, May 29, 1880.

[6] *Cincinnati Lancet and Clinic*, April 10, 1880; *Brit. Med. Journ.*, April 26, 1884; *Philada. Med. News*, March 17, 1883.

The following references may prove of service to the student:

Lebert: *Des Accouchements sans Douleur par l'Emploi du Bromure d'Ethyle*, Paris, 1882.
Wiedemann: *St. Petersburg med. Wochenschrift*, 1883, No. 11.
Häckerman: *Berlin klin. Wochenschrift*, 1883.
Müller: *Ibid.*, No. 44, and *Archiv für Gyn.*, Bd. xxii. H. 1, p. 99.
Ducasse: *Essai sur l'Emploi du Bromure d'Ethyle, etc.*, Paris, 1883.

The mode of application has been by solution or ointment applied to the cervix and vulva. In private practice it is doubtful if patients would generally permit application to the former, as it could only be efficiently done with a speculum.

There are no contraindications to the local use of cocaine; the application is perfectly safe; no constitutional effects have thus far been recorded.

That a local anæsthetic the effects of which are so nearly limited to the surface should prove efficient in mitigating the pains of labor does not seem probable. The origin of the suffering is too deep and its extent too widespread to be controlled by any outward application. There is no doubt it can mitigate some portion of the suffering depending upon stretching and tearing of the soft parts, and in the absence of more powerful and more reliable anæsthetics would prove a valuable resource. The obstetrician should carry a vial of the solution in his case. If suture of the perineum should be necessary, it will render valuable service.

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## THE USE OF ETHER IN OBSTETRIC PRACTICE.

By the Editor.

In those portions of this country where ether is the sole anæsthetic used for surgical purposes, it is very apt to be the agent employed not only to produce the deep anæsthesia necessary for most of the obstetrical operations, but also as an analgesic to mitigate the pains of labor. This is natural enough, for the student in many of the Eastern colleges may complete his whole medical course without once seeing chloroform narcosis: he is told by the professors of surgery and of therapeutics[6] that chloroform is a dangerous substance, while ether is perfectly safe;[1] he frequently sees ether administered in the clinics, and perhaps as an advanced student administers it himself; so that it is little wonder that one so educated should choose in his subsequent practice, whether obstetrical or surgical, that anæsthetic agent with which he is familiar, instead of another against which he has been warned, with the mode of administration of which he is unfamiliar, and of the effects of which he is practically ignorant. And, moreover, ether will be found most satisfactory to the obstetrician if used with skill and judgment. It is astonishing how little of this anæsthetic is needed to secure the desired effect if the administrator is experienced in its use and endeavors to employ it as sparingly as possible—an object always to be aimed at, for the sick headache, the intense nausea and vomiting, and the irritation of the air-passages which follow a careless and profuse use of ether can all be avoided if care is exercised, in its administration, to give only so much as will produce the degree of anæsthesia that is desired.

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[1] B. C. Hirst: *Philada. Med. News*, Oct 30, 1886.

[2] Parvin: *Obstetrics*.

[3] Partridge: *N. Y. Med. Record*, July 10, 1886.

[4] *Philada. Med. News*, May 22, 1886.

[5] *Brit. Med. Journ.*, 1885, ii. pp. 473, 1159.

[6] "So dangerous is chloroform, and so safe is ether, that there is no excuse for the use of the former agent under ordinary circumstances" (Wood's *Therapeutics*, 3d ed., p. 283)—a dogmatic assertion that is scarcely justified in view of the fact that by far the larger portion of the civilized world uses chloroform exclusively as an anæsthetic.

The influence of ether upon the duration of labor, upon the uterine contractions, and upon the maternal soft parts is not materially different from that of chloroform, so clearly set forth by Dr. Reeve.

There are, however, certain minor points of difference which deserve consideration, while the mode of administration differs considerably. In regard to the influence of ether upon the duration of labor, one can with this remedy blow both hot and cold. In those cases, especially in primiparæ, in which the women are exhausted from prolonged effort, so that not only do the abdominal muscles fail to supplement the contractions of the uterus, but the uterine muscle itself grows weak from fatigue, ether, being one of the best diffusible stimulants, will often reawaken with renewed vigor the muscles engaged in the expulsion of the child, so that the administration of this anæsthetic will not infrequently obviate the necessity of instrumental delivery. Again, in those cases in which, during the second stage of labor, each expulsive effort causes such pain that the action of the abdominal muscles is inhibited, a mitigation of the suffering by the administration of any analgesic will result in the active co-operation of the abdominal muscles, and consequently a more speedy termination of labor. On the other hand, in those women who from excitement and pain are stimulated to a degree of frenzy in which, regardless of the pain they inflict upon themselves and deaf to the expostulations of the medical attendant, they summon every atom of muscular force at their command to terminate their intolerable suffering, any anæsthetic will calm the excitement and allow the labor to take a more natural and placid course. But in any case, ether, like chloroform, if pushed to an extreme degree, will diminish the contractile power of all the muscles, and thus not only retard labor, but predispose to post-partum hemorrhage. In those cases in which the suffering can be borne without much complaint, or in which the pain is not too great to interfere with the proper degree of muscular action, or when the labor is not too prolonged, it is, in the writer's opinion, better to dispense with an anæsthetic altogether.

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[1] As a student, as an interne in several large hospitals, and formerly as the official anæsthetizer for a considerable time in the Hospital of the University of Pennsylvania, I have had some experience in the use of ether as a surgical anæsthetic, as well as in its employment in obstetric practice; and while it is true that ether requires less care and watchfulness in its administration than chloroform, yet the idea that the former agent is entirely safe is altogether erroneous. Quite recently, during a difficult breech extraction, I nearly lost a patient from ether asphyxia. She had stopped breathing, her pulse was thirty to the minute, her face had passed from cyanosis to the ashy hue of death. It was only after the vigorous application of artificial respiration for more than half an hour that the patient partially recovered, while her condition gave me great anxiety for several hours. The administration of the ether had in this case been entrusted to a skilled nurse.

*Method of Administration.*—After trying the familiar cone and various forms of inhalers, all more or less complicated, I have found most convenient and suitable a rather thin towel or napkin folded once and laid lightly over the patient's nose and mouth. The ether is dropped upon the compress, only by three or four drops at a time, at the close of every expiratory act, directly below the point of the patient's nose. In this way none of the vapor is driven away from the nose and mouth by the expired air, but all of it enters the lungs at the next inspiration, and the individual is in a few seconds—in my own case after two deep inspirations—irresponsive to a sharp pinch or the prick of a knife. I believe, from experiments upon myself, that analgesia is more quickly produced by ether than by chloroform, although unconsciousness and surgical anæsthesia more quickly follow the administration of the latter. Narcosis once established by ether, it is sufficient to let fall only a drop or two directly beneath the nose at about every alternate inspiration, in order to keep the patient unconscious and insensible. If this course is pursued, there will not be the stertorous breathing, frothing mouth, and deeply-congested face only too familiar in many of the surgical clinics where ether is habitually administered. If ether is given as an analgesic to mitigate the labor-pains—and for this purpose I believe it to be superior to chloroform—it should be administered, of course, just as the pains come on, while in the intervals the administration may be discontinued. Satisfactory as ether is under ordinary circumstances, there are certain cases in which chloroform must be preferred. In eclampsia, as it is necessary to speedily secure muscular relaxation, and as it is important to avoid the high arterial tension and cerebral congestion that always follow the administration of ether, chloroform should be the anæsthetic employed. In cases of renal disease without eclamptic seizures ether is not safe, nor is it wise to use it if there is congestion or inflammation of the air-passages. When there is reason to suspect an atheromatous condition of the arteries of the brain, the danger of precipitating an apoplectic attack by the use of ether must be borne in mind.[1] In any case, moreover, in which an anæsthetic is to be used continuously for a long time, chloroform will answer better, for ether, like all stimulants, if used too long or pushed too far, becomes a profound depressant. In the clinic of the late Professor Schroeder of Berlin, and in the Frauenklinik at Munich under Professor Winckel, I have seen chloroform used continuously for many hours in cases of eclampsia, with apparently no ill effect. Aside from the positive dangers of a prolonged use of ether, a disagreeable after-effect — not, I believe, generally referred to — is a delay in the establishment of the milk secretion of from twenty-four to forty-eight hours beyond the usual time for that occurrence. This has been often forced upon my notice, and it has seemed, moreover, in these cases that the first supply of milk disagrees with the infant, which is apt to be peevish and colicky during the first week.

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[1] See "A Death during, and a Death before, the Administration of Ether," D. Hayes Agnew, *Med. News*, Nov. 19, 1887. The death during the administration of ether was caused by the rupture of an atheromatous artery in the floor of the fourth ventricle.

# ANOMALIES OF THE FORCES IN LABOR.

BY THEOPHILUS PARVIN, M. D., LL.D.,

PHILADELPHIA.

### ANOMALIES OF THE EXPULSIVE FORCES.

THE forces concerned in birth are manifested by uterine and abdominal contractions. Considering labor as divided into three stages, in the first of these the uterine force only is active, and it has therefore been termed the uterine period; but in the second the uterine action is assisted by contractions of the abdominal muscles, and hence this period is utero-abdominal; while in the third stage the action of the uterus is chiefly, in some cases exclusively, concerned.

The anomalies of force may be manifested in any one of these periods, and, as the consequences vary with the time of manifestation, it is necessary to consider them in each stage.

In the first stage of labor uterine action may be excessive, defective, or perverted, or may be attended with very great suffering.

*First: Intensity of Uterine Action.*—The uterine contractions are regular, frequent, and attended with rapid progress of the labor; indeed, the progress may be so accelerated that what the old obstetricians called precipitate birth occurs if the intensity of action continues in the second stage. If the soft parts present abnormal, or in some cases even normal, resistance, they may be torn by the violent uterine action, and hence injuries to the vagina, vulva, or perineum. Or, again, the child may be expelled while the woman is standing, and rupture of the cord or sudden dragging out of the placenta, or even inversion of the uterus, result, the child falling upon the floor. It is remarkable that serious injury to the infant has seldom been observed under these circumstances, and the explanation that has been suggested is that the force of the fall is broken by the mother's limbs and by the cord.

Even though all these dangers are escaped, the sudden emptying of the uterus may be followed by relaxation of the organ, resulting in hemorrhage. Further, this hemorrhage may be absent, but failure of uterine contraction, closing the blood-vessels corresponding with the placental site, thus causing a normal relative anæmia of the organ, may lead to unusually prolonged and severe after-pains.

In the second stage of labor there is usually associated with very vigorous uterine contractions a corresponding intensity of the action of the abdominal muscles. If this violent action of labor-forces is manifested, the obstetrician endeavors to guard against the possible dangers of abrupt delivery, and also seeks to lessen excessive force. The woman lies as nearly horizontally as possible, objects against which she can press with her feet or those that she can grasp with her hands being removed; she is urged to keep her mouth open and to refrain from all bearing down. It may be necessary besides to use morphia hypodermically or to give chloroform by inhalation. The exit of the presenting part is retarded by the hand until the vulvar orifice is sufficiently dilated to permit that exit without causing injury; some have advised for this retardation the use of the forceps; retraction of the uterus during and immediately after the expulsion of the child is secured by suitable application of the hand upon the organ through the abdominal wall—"following down the womb," as expressed by the Dublin school—and slightly compressing the organ, ready to increase that compression should its relaxation occur.

*Feebleness of Uterine Action.*—This may be manifested in the first, in the second, or in the third stage of labor; it may vary from weak and widely-separated uterine contractions in the first or in the second stage of labor to inertia in the latter, or to complete atony in the third stage. Prior to complete dilatation of the mouth of the womb feeble contractions may be observed either before or after the rupture of the membranes. Such defective uterine action may have characterized the labor from the beginning, or may not have manifested itself until after hours of vigorous but unproductive uterine contractions.

The causes of defective uterine action are many. It may be the consequence of general feebleness, as from protracted and exhausting disease, or the muscular tissue of the uterus may not be perfectly developed; hemorrhages may have resulted in not only general weakness of all the muscles, but also in those of the uterus. Very great distension of the uterus, as from plural pregnancy or from polyhydramnios, may cause such stretching of the muscular fibres that they cannot contract efficiently. Unfavorable positions of the uterus, as from excessive obliquity or from extreme anteversion, may be attended with weak action of the organ. The same fact may be observed in unfavorable fœtal presentations: as so clearly presented by Depaul, there is a certain physiognomy of labor corresponding with the presentation; for example, if the vertex descends first, it by uniform pressure upon all parts of the cervical ring evokes stronger uterine contractions, and more frequent than if the breech presents, because the latter is illy adapted to the space and cannot exert uniform pressure; hence the labor in the latter presentation is more protracted than in the former—may become, indeed, "tedious." The condition of adjacent reservoirs—that is, the rectum and the bladder—may lessen uterine action; thus, if these organs are full the progress of the labor may be slow, while it is quickened when they are emptied. A high temperature lessens force, and hence the importance of having the room occupied by the parturient not only well ventilated, but kept cool.

Finally, the condition of the mind exercises an important influence in some cases upon uterine contractions. All obstetricians are familiar with the fact that the pains of labor, hitherto quite active, may be arrested by the entrance into the room of an unexpected professional attendant; and thus uterine action, which is independent of the will, may be at once stopped by any strong emotion, such as surprise or disappointment. It sometimes also happens that the presence in her room of some one who may be disagreeable to or disliked by the parturient, causes uterine action to become feeble or irregular. The obstetrician wise to discover such source of disorder, and with sufficient resolution and tact to have the unconsciously offending party withdraw, will be rewarded by seeing a most favorable change in the character of the labor: the personal antipathies as well as the sympathies of a woman in labor should be considered, and such action taken as will avert the former and respect the latter.

La Motte[1] has given a very graphic account of his having been called to a certain marquise who was in labor, and finding upon examination that the "infant was well placed, the bag of waters formed, and the membranes ready to open at the first pain, I thought she would soon be delivered, not only because of these almost certain signs, but also because of her great complaints, her violent movements, and by her impatience and almost continual agitation—this which experience can tell better than one can describe." But, he adds, this state "changed almost as soon as she was placed on the bed for delivery, from the fear that my eyes as well as my hands would be used in delivering her. A lady who was present, and to whom she made known her anxiety, assuring her that she was mistaken, the pains returned even with greater vigor, and in a short time labor ended."

This wise accoucheur also mentions an instance of a woman being in active labor which was at once suspended by the coming in of one of her neighbors, who insisted upon offering her undesired services. La Motte, apparently intuitively recognizing the cause of the arrest of labor, kindly invited the visitor to go and lie down, promising to call her when she was needed. Her leaving the room was followed by immediate return of uterine contractions, and the labor was speedily ended.

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[1] *Traité des Accouchemens*, 1726.

The depressing influence of deep grief or of great fear may be manifest in feeble uterine action. In such cases the obstetrician endeavors to evoke an antagonistic emotion or sentiment; he seeks to inspire the timorous with hope, and the sorrow-stricken, if not with joyful anticipations, at least with resolute will and obedience to the demands of duty.

The fact of the fœtus being dead has been thought by some to protract the labor, because the living fœtus by its movements is claimed to irritate the uterus and thus increase its activity.

Idiosyncrasy is alleged by some to be manifested by want of efficient uterine contractions, and thus some women always have tedious labors, unexplained by any pelvic deformity. It is, however, probable that these cases of supposed idiosyncrasy as the cause of feeble uterine contractions, would upon sufficient examination be found dependent upon imperfect development of the muscular tissue of the uterus.

The diagnosis of inefficient uterine contractions rests chiefly upon the slow progress of the labor or upon its arrest. Moreover, the contractions are separated by wider intervals than normal, and each contraction seems to stop before attaining natural intensity. The following passage from Zweifel[1] will assist in providing against a dangerous mistake in some cases of apparently weak labor-pains:

"In abnormal relations of space, especially in contracted pelvis and in a rigid, unyielding os uteri, weak labor-pains have a very different signification. One should believe that after the definition of weak labor-pains—the uterine contractions occur at distant intervals, are too short, and do not attain the general intensity as to the hardness of the musculature—there could not exist any difference of opinion, and especially no oversight. We have already briefly referred to the fact that it is necessary to make thorough examination of the entire uterus if one will avoid false conclusions; and to enforce this I adduce an experience in the case of a young primipara with greatly contracted pelvis, in regard to whom two physicians held an entirely different opinion as to the labor-pains. One asserted that no regular pains were present, while the other maintained that it was a case of so-called uterine tetanus, and that the uterus was almost continually contracted. Both always examined for a contraction of the uterus, but one placed his hand upon the pubic region, and the other upon the fundus of the uterus. When I arrived I found the contraction-ring had ascended halfway to the umbilicus. The lower portion of the uterus extending down to the pubic symphysis was bladder-like and felt like a sail filled by the wind. Otherwise the furrow of the contraction-ring was not directed transversely across the abdomen, but obliquely; on the left side it was the breadth of a hand higher than on the right side; the uterine horn was situated upon the right side. The uterine fundus was very much contracted; the lower part was exceedingly thin from stretching, and near being ruptured in consequence of the labor-pain. These are conditions which we recognize and understand better from Bandl's work."

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[1] *Lehrbuch der Geburtshülfe.*

The prognosis varies in gravity according to the period in labor when this anomaly of uterine action occurs. Should slow or inefficient uterine action be manifested in the first stage of labor, the membranes being unruptured, the child suffers no harm from the delay; and even if the membranes have ruptured, it is most probable that sufficient liquor amnii remains to protect the cord and fœtus from injurious pressure, for it is well known that a part of the amniotic liquor may be discharged several days, if not some weeks, before birth, and the child then delivered living. However, it is not frequent that weak pains occur in the first stage of labor after the flow of the amniotic liquor. The prognosis, so far as the mother is concerned, is usually spoken of as favorable. Yet some qualification should be made, for an unduly prolonged first stage of labor may so exhaust the woman that her strength utterly fails in the course of the second or of the third stage, and in the latter the uterus falls into such an atonic condition that dangerous, even fatal, hemorrhage may occur.

The treatment of many of the cases of defective uterine action is in part suggested by the etiology, essentially consisting in the removal of the cause. Thus, a full bladder or rectum is to be emptied; an abnormal situation of the uterus remedied by a change in the patient's position or by the application of a bandage; if there be excessive right[1] obliquity of the uterus, for example, the woman must lie upon her left side, and Dr. Barker has even spoken of extreme anteversion in which the labor made better progress by having the woman lie not only upon her back, but also with the hips elevated; excessive distension of the uterus is to be relieved by evacuating the liquor amnii, provided the os be dilated or readily dilatable, as it usually is in case of such large expansion of its cavity.

In case of prolonged first stage of labor, the pains occurring at long intervals and accomplishing little or nothing, such condition occurring more frequently in primiparæ, the parturient deprived of sleep and becoming discouraged as well as weakened, it is often advisable to suspend uterine action and secure needed rest for her by a full dose of opium. She wakens usually after a few hours' rest refreshed, and the labor takes a normal course. In other instances of delay, taking

[1] Deventer not only speaks of right and left obliquity of the uterus, but also of anterior—by this meaning that which is now referred to as anteversion or anteflexion—and of posterior obliquity. The last is, of course, impossible.

some simple food or a warm drink—as a rule, the use of alcohol in any form is forbidden—will be followed by efficient uterine action.

If more decided means are required in the first stage of labor, the membranes being unruptured, the introduction of an aseptic bougie between the ovum and the uterine wall may be employed; still further, irrigations of hot water, continued for fifteen or twenty minutes each time, in the vagina may be used. If further interference be demanded, dilatation of the os by means of Barnes' or similar dilators may be resorted to, not merely for their direct effect in overcoming the first obstacle to the descent of the presenting part, but with the strong hope that the pressure of the dilators may evoke vigorous uterine contractions. The latter effect has been produced by some—notably by Dr. Isaac E. Taylor and the late Dr. Albert H. Smith—by introducing the forceps and bringing the head down to the os at each pain, but not making any attempt at extraction.

The employment of electricity to increase deficient uterine action has some advocates; such employment, however, can hardly become general in the profession, but it will usually be restricted to lying-in hospitals.

Should failure of uterine force come on in the second stage of labor, possibly uterine contraction may be excited by friction made upon the fundus of the uterus, or assisted by uterine compression according to the method known as Kristeller's. Some have thought that uterine contractions are increased in force by quinine; for example, three doses of six grains at intervals of twenty minutes. The medicine will do no harm, but quite frequently is not followed by any good.[1] The temptation to give ergot is often very great, but only in exceptional cases is this remedy advisable, for it may excite the uterus to a tetanic action, which carries peril to the life of the child and danger of more or less serious injury to the mother. But, for example, in a multipara, the presentation and the position of the child being favorable, its size normal, and the birth-canal ample, so that with a few vigorous pains the fœtus will be expelled, ergot may be used in small doses; for it seems probable that when such doses are given the normal uterine contractions are only made stronger, and continuous contraction, which is so perilous to mother and child, does not occur. But let it be remembered that only ten drops, for example, of the fluid extract of ergot should be administered, and then, if necessary, the dose repeated at intervals of fifteen minutes, until thirty, or at most forty, drops have been administered. In case there are objections to the use of ergot, delivery by the forceps, or in some cases in which the head is not in the pelvic cavity by podalic version, will be indicated.

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[1] "Whatever action has been observed from cannabis indica, quinine, digitalis, and also from pilocarpine, in increasing labor-pains, is probably due to the general action of these drugs. In that case their action does not differ greatly from that of a glass of wine or a cup of coffee. In fact, we often see that anything refreshing given to the patient, who in consequence of great suffering could not eat anything for a long time, acts wonderfully, and that with this increasing strength pains are favorably influenced."—*Zweifel.*

Uterine inertia in the third stage of labor is to be guarded against by frictions and compression of the uterus through the abdominal wall, and thus spontaneous detachment and extrusion of the placenta, such removal being assisted by a *vis a tergo*, rather than effecting it by pulling upon the cord, or by a *vis a fronte*.

The subject of post-partum hemorrhage consequent upon uterine atony will be considered in another part of this paper.

*Perversion of Uterine Action.*—Perverted uterine action may be general or local. In the former the uterus, instead of being alternately contracted and relaxed, remains in almost continuous contraction, and is rigid, resisting, instead of at regular intervals yielding to, external touch or pressure. This condition of excessive irritability of muscular fibre may arise from abnormal resistance, as malpresentation of the fœtus, pelvic narrowing, or obstruction from tumors, or it may be the result of that meddlesome midwifery which is perpetually "touching" or striving to dilate the os with the fingers, or follow the untimely administration of ergot or from giving it in too great a quantity. To abate this violent action of the uterus the most valuable remedies are a prolonged warm bath, hypodermic injections of morphia, or opium by the stomach or rectum, or chloral and inhalation of chloroform.

Local perverted uterine action is observed most frequently in what is known as spasmodic contraction of the os uteri. The os is tense as a cord during uterine contractions, and for a time at least these seem powerless to overcome the resistance. Such condition is most frequently seen in nervous, irritable primiparæ. After a while, however, and without the interference of the practitioner, the action of the fundus and the body of the uterus becomes stronger, and the obstacle is overcome in most cases. The practitioner will refrain from frequent examinations, and he may use chloral or morphia or employ anæsthetic inhalation if the pain be great or the spasm protracted.

Partial or local spasmodic action of the uterus may occur. It has been claimed that in rare instances strong and more or less continuous contraction may affect a portion of the body of the uterus, as in the case reported by Hosmer,[1] in which there was, according to Dr. Robert P. Harris,[2] tetanoid falciform constriction of the uterus. Charles[3] states that partial spasm of the body of the uterus is not common; it is characterized, in several cases, by a rigid, hard, circular band situated toward the middle or the inferior third of the uterus, forming a furrow, a sort of constriction like "a circle of iron." Nevertheless, these contractions, read in the light of recent knowledge, would be explained as not local, but as resulting from tetanic action of the uterus, marked by great ascension of what is known as Schroeder's contraction-ring. Such condition is illustrated in the case quoted from Zweifel, and will again be mentioned in connection with rupture of the uterus.

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[1] *Boston Medical and Surgical Journal*, 1878.

[2] Note to the American edition of *Playfair*.

[3] *Cours d'Accouchements*, 1887.

Kleinwächter denies the existence of partial uterine contractions, but maintains that in consequence of the relations of its muscular fibres to each other the uterus must contract as a whole. The so-called spasmodic contraction of the external os uteri is simply a condition in which the upper part of the uterus has not manifested enough power to overcome resistance; the os is only slightly dilated, and it presents sharp edges; but as soon as the contractions have become more vigorous it opens, the so-called spasm ceasing. Again, in the third stage of labor the placenta may not be spontaneously detached in consequence of adhesions, and the uterus takes the form of an hour-glass. The relaxed lower uterine segment represents a funnel, the narrowest portion of which is above. The upper portion of the uterus contracts around the remaining placenta, and immediately below the walls of the body meet, as nothing intervenes; but the lower segment is found, as after every normal birth, in a condition of partial paralysis; that is, it is relaxed. The so-called stricture, therefore, is not a pathological manifestation, but the normal condition after the birth of the child.

Spasmodic contraction of the os uteri has been most frequently observed. This may appear in the first stage of labor, causing more or less delay, or after the expulsion of the head the os may close about the neck of the child, the body remaining imprisoned in the uterus. Finally, after the complete expulsion of the child the placenta may remain in the uterus in consequence of what has been called hour-glass contraction.

It is probable that spasmodic contraction of the external os in the first stage of labor is usually to be explained as simply failure of force of uterine contractions to overcome the normal resistance there presented. Contraction of the external os about the neck of the child, if this really occurs—and eminent obstetricians have reported cases of it[1]—may be not so much the result of action of muscular fibre as a manifestation of the force of elasticity, as will be more fully explained. Finally, as taught by Kleinwächter,[2] the so-called hour-glass contraction of the internal os uteri after the expulsion of the child, resulting in temporary imprisonment of the placenta, may be simply a normal contraction of the entire body of the uterus, while the cervical canal, also in normal condition, remains loose and relaxed.

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[1] One of the most recent authorities sustaining the view that contraction of the external os around the neck of the child, thus furnishing a serious obstacle in delivery, may occur, is Varnier, *Annales de Gynécologie*, July, 1887. He asks, "Who has not seen in pelvic presentation the external os, insufficiently dilated or dilatable, contracted, after the expulsion of the trunk, around the neck of the child, rendering extraction extremely difficult, sometimes impossible?"

[2] *Grundriss der Geburtshülfe.*

Baudelocque, Dewees, and others have described contraction of the external os and that of the internal os after the complete or partial escape of the head or body from the uterus, the neck being so closely grasped by the constricting ring that delivery is arrested: the first variety is exceedingly rare, according to the statements of those who have observed it, while the latter is comparatively frequent: Charpentier asserts that in those cases in which the neck of the child is closely encircled, as has been stated, the contraction is at the internal os.

Now, it is not improbable that if the delivery of the shoulders through the external os, the head having passed out, is arrested, the apparent retraction of the ring arises simply from elasticity, and the delay in delivery is the consequence of the great size of the shoulders and want of vigorous uterine action, just as a similar delay is sometimes seen in like conditions after the expulsion of the head from the vulvar orifice. It certainly is not necessary to accept the hypothesis of contraction of the external os.

In regard to the second form of the disorder—that is, contraction of the internal os around the neck of the child—Dewees gave this explanation: "At the latter end of gestation the neck of the uterus is entirely effaced, but no sooner is the distending cause removed than the fundus, body, and neck set about moulding themselves into their original form," etc. The explanation of to-day is that the condition is not in itself pathological, but corresponds to a general contraction of the uterine body, the internal os included: it is thus seen that there is an important correspondence between the explanation given by the father of American obstetrics nearly a century ago and that now taught.

Accepting the explanations that have been offered, it is obvious that the treatment of these various conditions of local spasmodic contractions will greatly vary. In case of contraction apparently limited to the upper portion of the uterus, and occasioning long-continued unproductive uterine efforts, immediate artificial delivery is demanded. In spasmodic resistance of the external os in the first stage, lessen the pain which is associated with the condition by the use of an opiate or anæsthetic, and wait until the contractions of the body and fundus of the uterus can overcome the resistance. In elastic contraction of the external os around the neck of the child, immediately overcome it by stretching the ring with the fingers; at the same time, friction and compression of the uterus may be used, and the woman urged to bear down strongly, so that by these combined forces the resistance may be promptly overcome and the child liberated from the constriction which imperils its life. Imprisonment of the placenta from normal general uterine contraction, the so-called hour-glass condition, will end just as soon as normal uterine relaxation follows; in case immediate interference is demanded—by hemorrhage, for example—an anæsthetic and mechanical dilatation of the constricting ring may be employed. But this topic will be fully considered in another part of this paper.

Uterine contractions may be attended with excessive pain. The cause of this very great painfulness of "pains" the old accoucheurs attributed chiefly to rheumatism of the uterus, while most recent authorities usually fail to refer to it. Charles,[1] however, states that, as all muscles, the uterus may be affected by rheumatism. "The rheumatic pain may occupy different parts of the uterine wall; it is increased by pressure, by efforts, by movements; it is rarely fixed; most frequently it changes its place, disappearing upon one side, and is manifest upon the other; diminishes at one time, increases at another, ceases and returns without apparent cause."

In some cases the suffering is the result of a local parenchymatous metritis. Thus a woman a few days or a few weeks before her labor receives a blow upon the abdomen or similar injury results from a fall, and when labor sets in the part then injured is the seat of extreme suffering.

Probably, however, in the majority of cases the cause is to be found in excessive susceptibility to suffering and great general nervous sensibility. One of the old philosophers taught that man was the measure of the universe, but there never yet has been proposed means for measuring human pain; each individual estimates its intensity for himself, for herself. And so it comes that the suffering of childbirth, which one woman endures patiently and without complaint, in another produces intolerable agony, and may exhaust nervous power so that life itself is in peril.

The treatment of excessive suffering caused by uterine contractions is, plainly, since we cannot remove the cause, blunting the sensibility, and of course this is to be accomplished by opium or morphia, by chloral, or by inhalation of ether or of chloroform.

Anomalies of abdominal contractions may be manifested by excess, by defect—that is, irregular, insufficient, incomplete—or by entire absence. These contractions are chiefly voluntary; only at the close of the second stage of labor do they seem to escape entirely or almost entirely the dominion of the will. Such contractions exerted during the first stage of labor, and usually in the second stage if not synchronous with uterine action, are worse than useless. So, too, they are spending strength for naught if exerted when some invincible obstacle, as a malpresentation of the child or obstruction of the birth-canal, prevents delivery. Finally, excessive abdominal effort may contribute to the expulsion of the child before sufficient dilatation, especially of the vulvar outlet, has been accomplished, and tears result.

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[1] *Op. cit.*, Paris, 1887.

In the treatment of excessive abdominal contractions—that is, of such voluntary efforts untimely or violently made—much may be done by instruction of the patient; that is, teaching her when effort should be made and when she should refrain: at the close of the first stage of labor, if excessive voluntary effort threatens too rapid a delivery, she is directed to take frequent respirations, and objects which her feet can press or which she can grasp are removed, and it may be necessary to employ chloroform by inhalation.

It will sometimes be found that when an anæsthetic is given during labor the patient makes voluntary bearing-down efforts in the intervals between uterine contractions, solely for the purpose of having the anæsthetic given, its administration in most cases being limited to the periods of uterine action. This occasional phase of perversion of voluntary effort is witnessed sometimes by every obstetrician who uses anæsthetics in labor.

A primipara at the beginning of the second stage of labor frequently hesitates to exert abdominal contraction, fearing that this will increase her suffering. But this disorder of relation between abdominal and uterine force soon ceases. Oftener the abdominal contraction is interrupted by frequent inspirations, and the bearing-down effort is not continuous, thus leading in some cases to considerable loss of force.[1] The pearl-diver can remain under water for a minute or a minute and a half, and this fact has its significance with reference to the time a woman in labor can contract the abdominal muscles. She ought to be urged to continue that effort as long as the corresponding uterine contraction lasts.

Naegele gives the following as the chief cause of feeble abdominal contraction, and manifestly the treatment of the disorder will chiefly consist in, so far as possible, the removal of the cause: Insufficiency of force in abdominal contractions may result from those contractions being very painful, from the great feebleness of the patient from previous diseases, exhaustion produced by inopportune or premature efforts, difficulty of respiration in consequence of obesity, from bronchocele, vices of conformation, such as deviations of the vertebral column, inflammatory and spasmodic affections of the thoracic organs, diseases of the heart, hydrothorax, ascites, etc.

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[1] J. S. Mill has said that he could conceive a condition of things in which 2 and 2 are not 4, thus apparently denying that which most would regard as the simplest mathematical certainty. The accoucheur has frequent opportunities of observing that 1 and 1 are not 2, or that 1, 1, and 1 are not 3; that is, a voluntary abdominal contraction divided into two or three parts is not equal to an unbroken, uninterrupted effort.

In case of paraplegic women the expulsion of the child is accomplished by uterine action alone, and the general rule is that in these women the labor is longer than in those not thus affected. Nevertheless, numerous exceptions to this rule have been observed. For example, during my service in the obstetric department of the Philadelphia Hospital I have had under my care two paraplegic women, and their labors were not at all protracted. It has been suggested, in explanation of similar facts, that the deficient power of abdominal contraction has a compensation in diminished resistance of soft parts.

## ANOMALIES OF THE SOFT PARTS.

I. ANOMALIES OF THE UTERUS.—(*a*) *Anomalies of Development in Intra-uterine Life or During Pregnancy.*—In uterus bicornis, the pregnancy being single, there is a greater liability to transverse presentation of the child; and it has also been observed that in some cases the unimpregnated horn has interfered with the entrance of the child into the pelvis.

Two forms of anomalous development of the uterus during pregnancy have been observed, the one involving the anterior, the other the posterior wall. The former has been seen in some cases of unreduced[1] retroflexion of the pregnant uterus; while in the majority of instances this displacement of the uterus is incompatible with the continuance of the pregnancy, in exceptional ones the pregnancy has continued to, or near to, the normal time. The posterior wall and fundus of the uterus lie in the pelvic cavity, and the enlargement of the organ is chiefly at the expense of the anterior wall. The delivery in these cases has been artificial, and presents more or less serious difficulty.[2] In that reported by Stillé[2] it was accomplished by podalic version and extraction.

Depaul[3] reported in 1876 a case in which there was a sacciform[4] dilatation of the posterior wall of the uterus. In this instance it was impossible to find the os uteri, and, believing it completely closed, Depaul made an artificial opening. The woman died undelivered, and the subjoined illustration (Fig. 270) shows the condition found upon post-mortem examination.

Hernias of the uterus are exceedingly rare, and still more seldom met with are those in which the accident complicates labor. In some of the cases of this accident replacement of the organ was possible and labor was spontaneous; in at least one instance the Cæsarean operation was performed.

Prolapse of the uterus as a complication of labor is rejected by some recent authorities, they maintaining that the condition so described by former observers was really hypertrophic elongation of the vaginal portion of the neck of the uterus. Nevertheless, as representing the view hitherto held by most authorities, the following extract from the last edition of *Cazeaux* is given :

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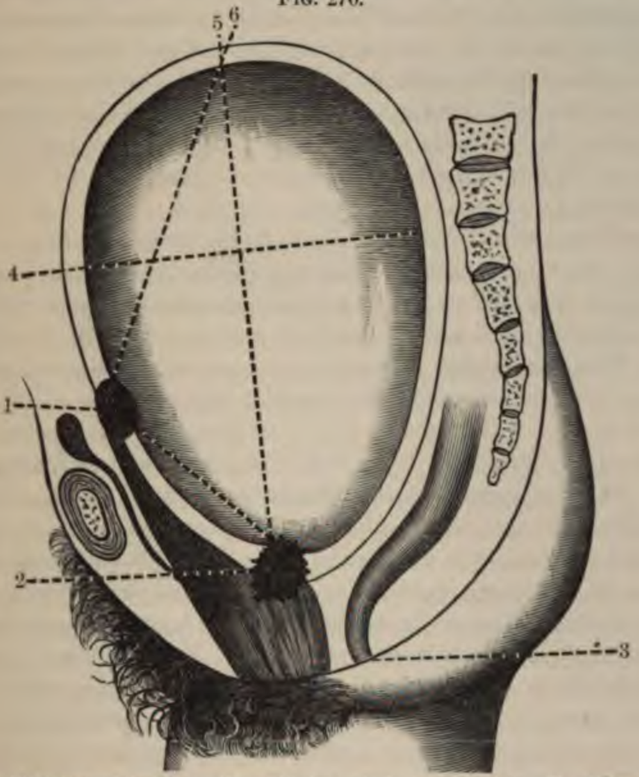
[1] *London Obstetrical Society's Transactions*, vol. i.

[2] *Memorabil.*, 1881.

[3] *Archives de Tocologie*, 1876.

[4] For a still earlier instance of such dilatation see Franke, *Monat. f. Geburts.*, 1853.

FIG. 270.



Sacciform Dilatation of the Uterus (Depaul): 1, os uteri; 2, artificial os. The distance between the two was about 3½ inches. The distance from the fundus of the uterus (6) to the os was 6.7 inches, while that extending from the same point (5) to the new opening was 9 inches. The distance from the os to the median point of the fundus was, following the curve of the anterior wall, 8.2 inches, but following the curve of the posterior wall, 18.1 inches.

"The prolapsus may prove a source of serious difficulty in the progress of the parturition, for experience has shown that this accident may not only be productive of long delays, but likewise of real danger; perhaps it may render the spontaneous expulsion of the fœtus altogether impossible, either, as has been long since remarked, because the womb, which has descended to the lowest parts of the abdominal enclosure, is removed, as it were, from the influence of the contraction of the abdominal muscles, or because, being wedged in between the surface of the child's body and the walls of the pelvis, it has lost a great part of its energy in consequence of long-continued pressure.

"The difficulties to be overcome will also vary according to whether the prolapsus be recent or of long standing; for in the latter case the prolonged contact of the organ with the internal face of the thighs and with the dress may have produced a state of induration of the cervix which opposes its steady dilatation; indeed, this has often been impossible, and the physician has been obliged to incise it to overcome the resistance offered by the indurated parts. On the contrary, where the accident has recently occurred, or, still better, if it is only manifested during labor, the dilatation is sometimes effected spontaneously and the duty of the accoucheur is limited to facilitating it by the use of appropriate means."

The statement made by the author as to the necessity of incisions of the cervix in certain cases testifies strongly in favor of hypertrophic elongation of that part demanding these incisions. Moreover, in none of the cases of alleged prolapsus of the uterus in labor is proof given that the fundus occupied other than its normal position or that any portion of the fœtus occupied the supposed prolapsed part of the organ.

Barnes states: "We have not seen a complete procidentia of the gravid uterus at term, but we have several times been called to see it. This is what we actually saw: an enormous fleshy mass protruded beyond the vulva, of a livid color, and presenting an opening—the os uteri—in its centre. On feeling the abdomen we have found at least a portion of the uterus, containing part of the fœtus, there. It was clear, then, that although the os uteri and cervix might be completely outside the vulva, the whole uterus was not." He then refers to one case to which he was called in which the condition was as represented in Fig. 103, taken from his works. That illustration, however, shows no prolapse of the uterus, but simply hypertrophic elongation of the cervix.[1]

Spiegelberg[2] recognizes prolapse of the uterus as a complication of labor, and remarks: "During the pains counter-pressure in an upward direction should be made, and the action of the abdominal muscles restrained as much as possible, since their contractions tend to increase the prolapse and incarceration of the lower segment of the uterus; indeed, it is possible for the uterus, when diminished by the discharge of the liquor amnii, to be to a great extent pushed out of the pelvis. When such is the case, as also when the mischief is less severe, delivery should be undertaken as soon as it appears at all necessary and permissible. It will of course be obvious that during the so-called third period of labor no traction must be made upon the cord; that when that stage is over the prolapse must be immediately and completely reduced; and that during the lying-in period the greatest watchfulness is necessary to keep the organs in situ."

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[1] *Obstetric Medicine and Surgery*, vol. ii. p. 549, Eng. edition.

[2] *Lehrbuch der Geburtshülfe.*

*Anomalies of the Os and of the Cervix.*—Occlusion of the os uteri presents two forms—the one a superficial obliteration which can be broken by the pressure of a probe or of the finger, and the other one in which the closure is not only complete, but resistant; the latter may have originated from the application of caustics or the injection into the vagina of caustic fluids during pregnancy. In the first form careful examination will reveal on some part of the hemisphere formed by the descending head enclosed in the lower segment of the uterus a depression or dimple corresponding with the normal position of the os, and the obstruction may be overcome by the means previously mentioned, subsequent artificial dilatation being, if necessary, employed. Very careful examination must be made in the second case to find the position which the os had occupied; if necessary, the hand should be passed into the vagina in making the search. The place having been found, a simple short incision is made with a convex bistoury wrapped nearly to its point with adhesive plaster; next multiple incisions are made with a probe-pointed bistoury, these incisions being about one-sixth of an inch in depth.

*Rigidity of the Os Uteri.*—The so-called spasmodic rigidity of the os has been considered and its appropriate treatment given, and we have now to consider an unyielding condition of the os arising from structural change caused by the formation of cicatricial tissue. In addition to this form of rigidity there may be in a case of premature labor or in an old primipara great resistance on the part of the os, so that the first stage of labor is very slow; but this organic rigidity can hardly be called a pathological condition, for in most cases the difficulty is overcome spontaneously and without either local or general injury. But it is otherwise in case of a stricture or stenosis of the os arising from the formation of cicatrices. Here one or more superficial incisions should be made, and for this purpose blunt-ended scissors may be employed. By some it is advised not to make any cut immediately anteriorly or posteriorly, lest a resulting tear may extend into the utero-vesical or into the utero-rectal cul-de-sac.

While the bleeding which follows incision of the external os in labor is usually very slight, in rare instances it has been quite severe. Thus, Laborie[1] has narrated a case of labor under the care of Dubois in which there was a face presentation, and the resistance of the os was so great that he made two incisions, one on each side; severe hemorrhage followed, so that cold-water injections failed to stop it. Immediate delivery being impossible, it was necessary to tampon the vagina: some hours afterward the woman was delivered with the forceps of a dead child. Dr. Guido Bell[2] of Indianapolis has reported a case in

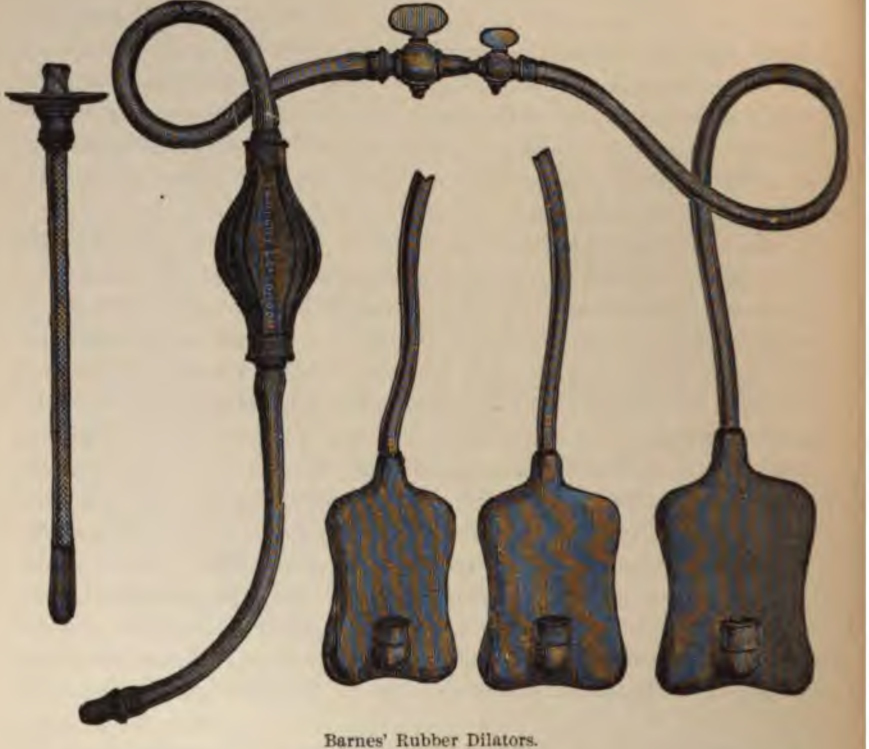
[1] *Gazette méd. de Paris*, 1846.

[2] *Memorabil.*, 1882.

which incision was followed by such profuse arterial hemorrhage that ligation of the bleeding vessel was necessary.

Warm baths, vaginal irrigations of warm water to which an antiseptic has been added, relieving the patient's mental anxiety and securing her rest if necessary, will constitute the treatment in what has been called organic to distinguish it from cicatricial rigidity. But if some accident arises and immediate delivery is required, then artificial dilatation of the os must be employed; and for this purpose the hydrostatic rubber dilators of Barnes are to be especially recommended.

FIG. 271.



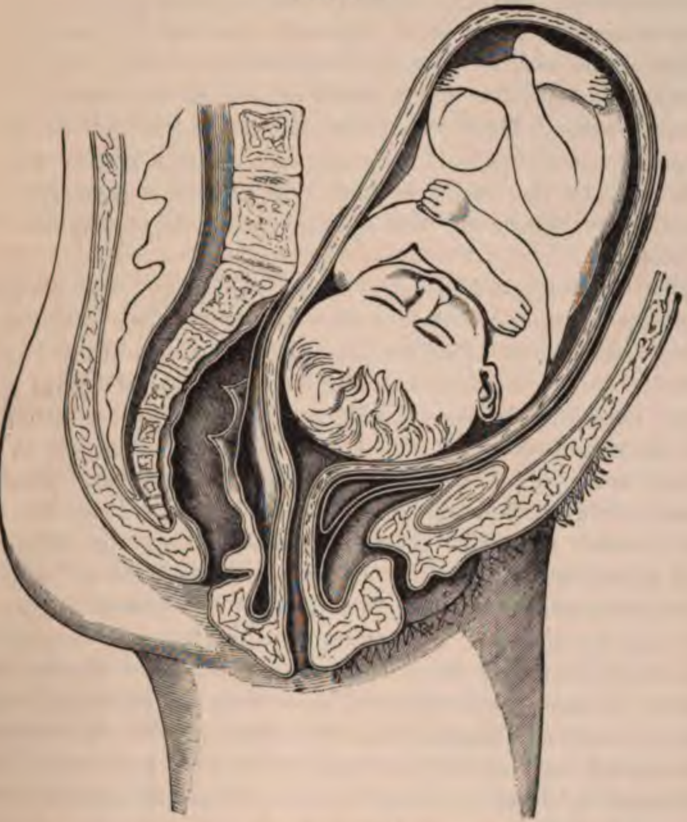
Barnes' Rubber Dilators.

Delay in dilatation of the os may be the consequence of strong adhesions between the membranes of the ovum and the lower portion of the uterus adjacent to the internal os: the remedy is rupture of the membranes.

Hypertrophic elongation of the cervix may present more or less serious obstruction to labor. The obstacle may be overcome in some cases by artificial dilatation or by this combined with incisions, so that delivery by the forceps or cephalotribe is practicable; but in others the indication for the Cæsarean operation is clearly presented.

Dr. Robert Barnes, from whom the subjoined illustration is taken, narrates a case in which the labor was impeded by an hypertrophied cervix: "A primipara, aged twenty-two, was in labor. The cervix protruded through the vulva about three inches, forming a mass equal to a man's wrist in circumference. After reducing the cervix in the vagina the head could be felt. The cervix had a hard, gristly feel. Free incisions in the os externum were made, so that the os externum was freely opened up to meet the natural expansion of the os internum. She was then delivered after an anxious labor of fifty-two hours."

FIG. 272.



Illustrating Labor with Hypertrophic Elongation of the Cervix.

Cancer of the cervix is one of the gravest complications of labor. Cohnstein's statistics show that of 126 women thus suffering, 72 died during childbirth or in the puerperal period. More recently, Stratz[1] found that in 7 cases of carcinoma complicating labor, 4 women died immediately after delivery, and 2 as a consequence of labor.

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[1] *Zeitschr. f. Geb. und Gyn.*, Bd. xii. Heft 2.

Baudelocque regarded the Cæsarean section as indicated in cases in which cancerous disease of the uterus obstructed delivery; and how much stronger the indication is in our day when this operation, properly performed, has just such a vastly lessened mortality!

The treatment, however, usually pursued is trusting largely to spontaneous dilatation, and, where required, assisting this expansion by incisions of the cervix. Dubois succeeded by cutting freely through the cancerous tissue, but if the latter be very thick, a serious hemorrhage may ensue. Most obstetricians, therefore, who advise incisions recommend that they should be made through that part of the neck, if such there be, that is not diseased. When either spontaneously or by art the os is sufficiently dilated, delivery is to be accomplished with the forceps.

One of the accidents of labor in these cases is rupture of the uterus; thus in the 60 cases collected by Chantreuil,[1] 6 women perished from rupture of the uterus. Further, as to the maternal mortality observed by him, 25 women died either during labor or in the puerperal period, and the remaining 33 either during that year or the succeeding one. 29 of the infants died, 23 were born living, and in regard to 3 no statement is given. Considering the great mortality, both fœtal and maternal, of this affection, it would be advisable to accept the teaching of Zweifel: in case the child cannot pass through the os, Cæsarean section is undoubtedly justifiable in all cases if the child be living.

Uterine myomata, whether of the body or of the cervix, complicate labor when by their size or position they interfere with the action of the uterus, obstruct the birth-canal, or prevent the dilatation of the cervix: a further complication may arise from the placenta occupying a position upon the internal wall corresponding with the position of an interstitial myoma, for the retraction of this part of the uterus being imperfect, closure of blood-vessels is incomplete and post-partum hemorrhage results.

Nevertheless, probably in a great majority of instances uterine myomata do not seriously interfere with labor nor with the normal course of the puerperal state. We may be misled by the observations made in lying-in hospitals, for probably only the graver cases have been found there. Stratz's[2] statistics show that of 13 women in whom labor was thus complicated, 7 died, and only 4 had a normal lying-in. Chabazian,[3] from the study of 310 cases of pregnancy complicated by these growths, found the proportion in which the neoplasm occupied the cervix to that in which it was seated in the body of the uterus was

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[1] *Du Cancer de l'Utérus au Point de Vue de la Conception, de la Grossesse et de l'Accouchement.*

[2] *Op. cit.*

[3] *Des fibromes du col de l'utérus au point de vue de la grossesse et de l'accouchement.*

1 to 5, while in the non-pregnant the relation is 1 to 20. The statistics show very clearly that growths involving the cervix interfere much less with conception and gestation than if otherwise situated. It is fortunate, as we shall presently see, that these neoplasms can thus in so many cases be from their situation more readily removed in case they interfere with labor.

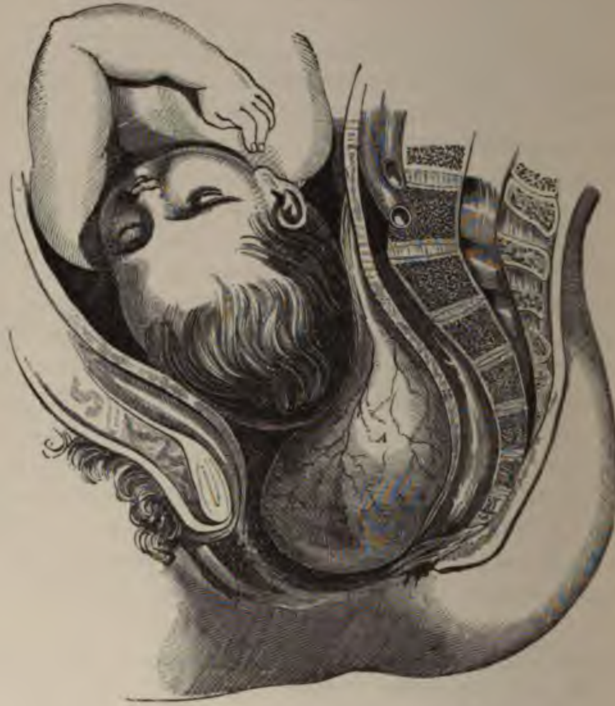
As might be expected from the uterus being deformed by the myoma, accommodation may compel an abnormal presentation; thus, the fœtus is much more frequently than in normal conditions of the womb found in a transverse position.

The general rule in the management of labor is to push the tumor out of the way if it prevents the entrance of the presenting part of the fœtus into the pelvic cavity: this pushing up the tumor has been done in some cases by having the woman in the knee-chest position. This disposition of the tumor has in some instances been accomplished, especially in case the growth had become pedunculated in the abdominal cavity. In some cases such a tumor that has fallen into Douglas' cul-de-sac can be readily thus pushed up in the abdomen, from the pedicle being quite long, one instance having been recorded in which the pedicle was twenty centimeters in length. In other instances the tumor, having become polypoid, and descending before the child, can be removed by amputating the pedicle with the écraseur, or it can be removed by enucleation if it be situated in either wall of the cervix: each of these operations has been several times successfully done during labor.

The gravest cases are those in which the tumor is interstitial, is situated in the lower portion of the uterine wall, and is so large that it is impossible for the head of the fœtus to enter the pelvic cavity. Here the decision must be made between craniotomy and the Cæsarean operation; and this decision should be made early, for either operation may end fatally from delay in its performance. If the tumor occupies the anterior uterine wall so that its incision is necessary for the removal of the child, then in addition to the Cæsarean operation myotomy must also be done, and this double operation makes the prognosis almost hopeless.

An ovarian tumor may complicate labor. The question of treatment will be determined chiefly by the size, consistence, position, and mobility of the growth. If the tumor be in the pelvis, possibly it may be pushed up into the abdominal cavity, so that the presenting part of the fœtus can descend; if immovable and cystic, puncture or incision may be necessary; but if it be solid, and thus fixed, the choice may be between the Cæsarean operation and craniotomy. Nevertheless, before opening the uterus ovariotomy should be done, and then probably the delivery can be effected through the natural passage. In case the tumor be large and abdominal, rupture of the cyst may occur or twisting of its pedicle; but rupture is not necessarily fatal, for how many instances are recorded in the non-pregnant without death! After dilatation of the os the danger of bursting of the tumor comes—that is, during the period of abdominal contractions: this danger is to be avoided by artificial delivery, and this delivery should be by the forceps rather than by version, the results when the former method was employed having been much more favorable than those obtained by the latter. It is also to be remembered that usually premature labor occurs in cases of pregnancy complicated by a large ovarian tumor.

FIG. 273.

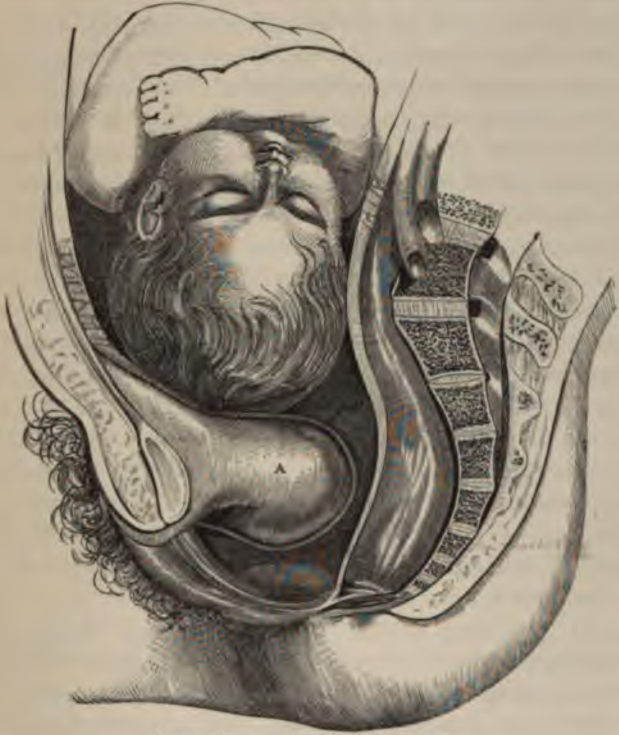


Ovarian Tumor complicating Pregnancy.

Obstruction of the vagina as a consequence of the rectum being distended with feces or the bladder with urine can only rarely occur. Ramsbotham has stated that he has seen many instances of the bladder prolapsing before the head, and mentions two in which it was punctured, one practitioner mistaking it for a dropsical head and the other for the bag of waters.

Dr. Busey at the last meeting of the American Gynecological Society presented a paper upon cystocolpocele complicating pregnancy and labor: by cystocolpocele is meant prolapse of the bladder into the vaginal passage; and if the sac occupies the cavity of the pelvis, filling the hollow of the sacrum, pushing the os uteri beyond reach and occluding the vaginal passage, it is complete. One of the most marked results of this displacement of the bladder is lingering labor. The diagnosis is made by introducing the catheter into the bladder and evacuating it. This displacement of the bladder in relation to pregnancy and labor was very fully considered by Broadbent in 1863 in a paper read before the London Obstetrical Society. In referring to the diagnosis he states: "The prolapsed condition of the bladder is readily recognized on examination, especially when it contains urine in any considerable quantity. The cavity of the pelvis is found to be occupied by a bag of fluid easily distinguished from the fœtal membranes by the fact that it springs from the pubis, and does not permit the finger to pass between it and the symphysis. As this sac, the bladder, fills up the hollow of the sacrum, the os uteri cannot be reached till the urine is evacuated; and if this is done by the catheter, the instrument can be felt from the vagina and followed to every part of the

FIG. 274.



Cystocele complicating Pregnancy.

"The difficulties to be overcome will also vary according to whether the prolapsus be recent or of long standing; for in the latter case the prolonged contact of the organ with the internal face of the thighs and with the dress may have produced a state of induration of the cervix which opposes its steady dilatation; indeed, this has often been impossible, and the physician has been obliged to incise it to overcome the resistance offered by the indurated parts. On the contrary, where the accident has recently occurred, or, still better, if it is only manifested during labor, the dilatation is sometimes effected spontaneously and the duty of the accoucheur is limited to facilitating it by the use of appropriate means."

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[2] *Lehrbuch der Geburtshülfe.*

*Anomalies of the Os and of the Cervix.*—Occlusion of the os uteri presents two forms—the one a superficial obliteration which can be broken by the pressure of a probe or of the finger, and the other one in which the closure is not only complete, but resistant; the latter may have originated from the application of caustics or the injection into the vagina of caustic fluids during pregnancy. In the first form careful examination will reveal on some part of the hemisphere formed by the descending head enclosed in the lower segment of the uterus a depression or dimple corresponding with the normal position of the os, and the obstruction may be overcome by the means previously mentioned, subsequent artificial dilatation being, if necessary, employed. Very careful examination must be made in the second case to find the position which the os had occupied; if necessary, the hand should be passed into the vagina in making the search. The place having been found, a simple short incision is made with a convex bistoury wrapped nearly to its point with adhesive plaster; next multiple incisions are made with a probe-pointed bistoury, these incisions being about one-sixth of an inch in depth.

*Rigidity of the Os Uteri.*—The so-called spasmodic rigidity of the os has been considered and its appropriate treatment given, and we have now to consider an unyielding condition of the os arising from structural change caused by the formation of cicatricial tissue. In addition to this form of rigidity there may be in a case of premature labor or in an old primipara great resistance on the part of the os, so that the first stage of labor is very slow; but this organic rigidity can hardly be called a pathological condition, for in most cases the difficulty is overcome spontaneously and without either local or general injury. But it is otherwise in case of a stricture or stenosis of the os arising from the formation of cicatrices. Here one or more superficial incisions should be made, and for this purpose blunt-ended scissors may be employed. By some it is advised not to make any cut immediately anteriorly or posteriorly, lest a resulting tear may extend into the utero-vesical or into the utero-rectal cul-de-sac.

While the bleeding which follows incision of the external os in labor is usually very slight, in rare instances it has been quite severe. Thus, Laborie[1] has narrated a case of labor under the care of Dubois in which there was a face presentation, and the resistance of the os was so great that he made two incisions, one on each side; severe hemorrhage followed, so that cold-water injections failed to stop it. Immediate delivery being impossible, it was necessary to tampon the vagina: some hours afterward the woman was delivered with the forceps of a dead child. Dr. Guido Bell[2] of Indianapolis has reported a case in which incision was followed by such profuse arterial hemorrhage that ligation of the bleeding vessel was necessary.

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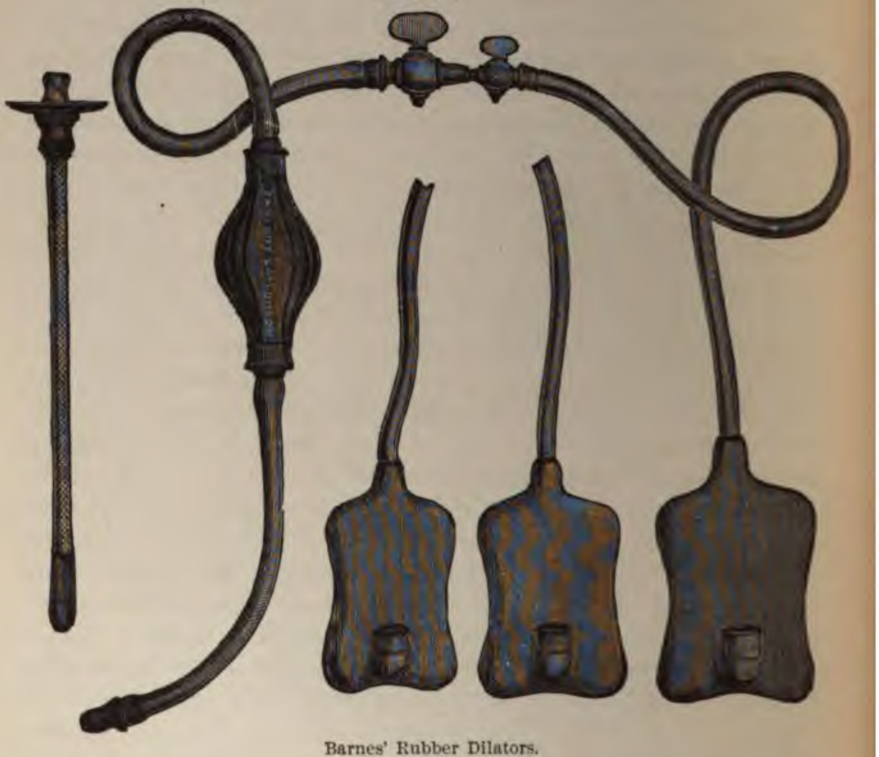
[1] *Gazette méd. de Paris*, 1846.

[2] *Memorabil.*, 1882.

Warm baths, vaginal irrigations of warm water to which an antiseptic has been added, relieving the patient's mental anxiety and securing her rest if necessary, will constitute the treatment in what has been called organic to distinguish it from cicatricial rigidity. But if some accident arises and immediate delivery is required, then artificial dilatation of the os must be employed; and for this purpose the hydrostatic rubber dilators of Barnes are to be especially recommended.

FIG. 271.



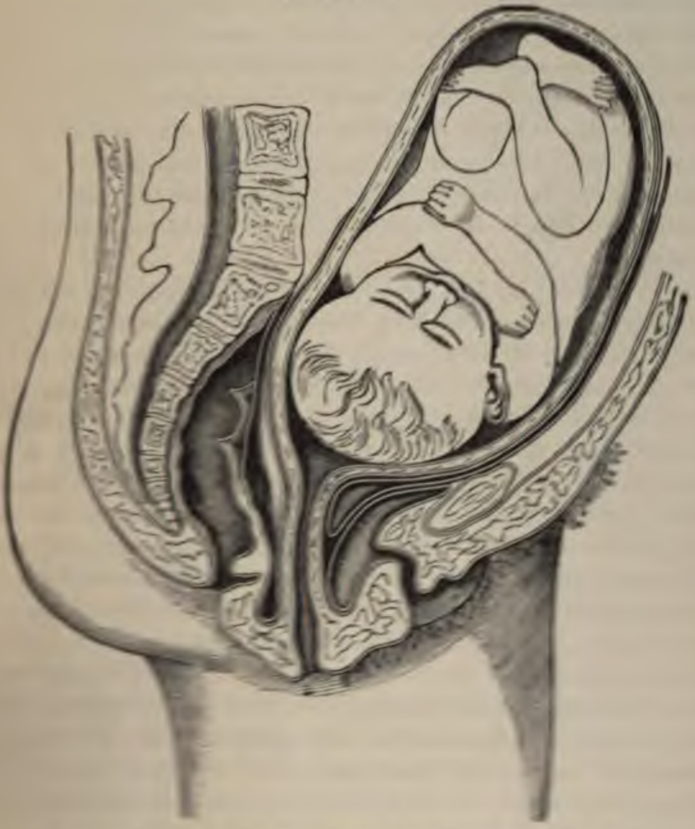
Barnes' Rubber Dilators.

Delay in dilatation of the os may be the consequence of strong adhesions between the membranes of the ovum and the lower portion of the uterus adjacent to the internal os: the remedy is rupture of the membranes.

Hypertrophic elongation of the cervix may present more or less serious obstruction to labor. The obstacle may be overcome in some cases by artificial dilatation or by this combined with incisions, so that delivery by the forceps or cephalotribe is practicable; but in others the indication for the Cæsarean operation is clearly presented.

Dr. Robert Barnes, from whom the subjoined illustration is taken, narrates a case in which the labor was impeded by an hypertrophied cervix: "A primipara, aged twenty-two, was in labor. The cervix protruded through the vulva about three inches, forming a mass equal to a man's wrist in circumference. After reducing the cervix in the vagina the head could be felt. The cervix had a hard, gristly feel. Free incisions in the os externum were made, so that the os externum was freely opened up to meet the natural expansion of the os internum. She was then delivered after an anxious labor of fifty-two hours."

FIG. 272.



Illustrating Labor with Hypertrophic Elongation of the Cervix.

Cancer of the cervix is one of the gravest complications of labor. Cohnstein's statistics show that of 126 women thus suffering, 72 died during childbirth or in the puerperal period. More recently, Stratz[1] found that in 7 cases of carcinoma complicating labor, 4 women died immediately after delivery, and 2 as a consequence of labor.

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[1] *Zeitschr. f. Geb. und Gyn.*, Bd. xii. Heft 2.

When she had rested somewhat, I made an examination, first *per vaginam,* and then *per rectum.* In the vaginal canal there was a large mass enclosed in a sac which almost completely obstructed the passage, only permitting the entrance of the finger after first pressing the obstructing mass backward toward Douglas' cul-de-sac, and then downward toward the perineum. After manipulating it in this manner, I was enabled to get my finger up to the os, which was dilated to the size of a silver dollar. After waiting for some time I ruptured the membranes, but still there was little or no progress. My next examination was *per rectum,* which enabled me to distinctly outline a fœtus (cranial bones next my finger) enclosed in the sac already described. The diagnosis, to my mind, was clear beyond doubt of a uterine and an extra-uterine pregnancy. I informed the husband of the state of affairs, and asked permission to call a consultation. Drs. Reyfus and Skilling were accordingly summoned. I told them of my diagnosis, and after an examination they fully concurred as to the condition of affairs. No time was now to be lost, for the woman was constantly sinking; pains were frequent; the uterus was forcing the living child down, but it was impossible for it to be expelled, owing to the obstructing mass which occupied the passage. Dr. Skilling suggested the application of the forceps to bring down the living child. It was decided, however, that this could not be done. I proposed to give ether and to cut the posterior wall of the vagina which formed the anterior wall of the sac. This we did, removing with forceps a blighted fœtus of six months, after removing by cutting and ligating as much as possible of the sac and membrane. Now we turned our attention to the uterus, and found that the child had rotated and assumed the occipito-posterior position. I applied the forceps again, and delivered a living female child weighing about eight pounds. The ether was now withdrawn. The patient was made as comfortable as was possible under the circumstances, and we concluded to await developments. The hemorrhage was not very excessive. Nothing further was done except to maintain her strength by administering some stimulants. At 10 o'clock the following morning, by appointment, Drs. R. and S. and myself met, and after taking temperature we put her upon appropriate treatment. She was very much exhausted, and we therefore concluded to disturb her as little as possible. A period of seven hours had now elapsed since delivery. The temperature was $101\frac{2}{5}°$, pulse 128. On the second day, *i. e.*,

| | | | | | | |
|---|---|---|---|---|---|---|
| January | 25, | Temperature, | 101°, | Pulse, | 120. | |
| " | 26, | " | 100, | " | 98. | |
| " | 27, | " | $100\frac{3}{5}$, | " | 98. | Belly tympanitic; third day, very tender, with promise of peritonitis; fourth day, peritonitis |
| " | 28, | " | 100, | " | 96. | |
| " | 29, | " | $99\frac{1}{2}$, | " | 92. | |

| | | | | | |
|---|---|---|---|---|---|
| January | 30, | Temperature, | 101°, | Pulse, | 92. |
| " | 31, | " | 101⅕, | " | 96. |
| February | 1, | " | 101, | " | 96. |
| " | 2, | " | 99⅖, | " | 84. |
| " | 3, | " | 99⅗, | " | 92. |
| " | 4, | " | 99½, | " | 86. |
| " | 5, | " | 99, | " | 84. |

very pronounced, which continued till the seventh or eighth, when it began to decline until the period of convalescence.

"We never varied our treatment from the beginning, keeping her quiet with opiates, administering quinine in antiperiodic doses, and using alternately antiseptic injections of bichlor. mercury and carbolic acid. I visited her this afternoon, February 11, 1888, and found her dressed and feeling quite strong, and was met by the inquiry from her as to when she would be able to resume her household duties."

## ANOMALIES OF THE PELVIS.

Anomalies of the pelvis may be conveniently divided into those of position, of size, and of form.

The first division includes two varieties. The pelvis has a normal inclination or obliquity, and the deviations from this obliquity may be by excess or by defect; that is, the inclination may be increased or lessened.

So, too, the second division includes two classes—1, that in which the pelvis undergoes uniform increase, pelvis æquabiliter justo-major; and 2, that in which similar decrease occurs, pelvis æquabiliter justo-minor. The latter is described as a pelvis uniformly contracted: in order that a pelvis may be called contracted the true conjugate must be lessened one centimeter and a quarter, but if there be a uniform lessening of all the diameters one centimeter, or about four-tenths of an inch, then general contraction is said to be present.

The third division includes those characterized by change in the pelvic form: in the second class there are simply changes in size, the pelvis remaining symmetrical, but in this it becomes asymmetrical—its form perverted, or the pelvis is said to be deformed, and, so far as the injurious results in relation to labor are concerned, vitiated. Such deviations from the normal may involve the vertical diameters with reference to the transverse, or the latter with regard to each other, and these constitute the chief ones to be considered. The last presents three classes: 1, that in which the antero-posterior diameter is lessened; 2, the transverse diameter is lessened; and, 3, the diminution is in the oblique diameter.

These various pelvic anomalies will now be considered in the order that has been given.

I. ANOMALIES OF POSITION.—As already stated, deviations from the normal obliquity of the pelvis are two; this obliquity may be increased or lessened.

Lobstein,[1] in an unpublished memoir presented to the Society of Medicine of the Faculty of Paris, 1817, first directed the attention of obstetricians to the consequences of too great or too slight inclination of the pelvis. The anterior obliquity may be so exaggerated that the axis of the inlet is horizontal. Moreau narrates a case in which the plane of the inlet was vertical, and there was also associated with this vicious inclination of the pelvis narrowing from rickets, which compelled the Cæsarean operation. Naegele has described the case of a married woman in whom the inferior strait was turned directly behind; the pubic symphysis and the upper part of the sacrum were directed horizontally, and consequently the plane of the superior strait was vertical: the venereal act never took place but in a position opposite to the natural one. She became pregnant, but the pelvis being normal no difficulty occurred at labor; six other consecutive pregnancies occurred, and ended with the same facility as the first.

By so-called posterior obliquity—a true obliquity in a backward direction of course is impossible—is generally understood a marked lessening of the normal obliquity, that may go to such extreme that the plane of the inlet becomes horizontal. This obliquity is usually associated with deformed pelvis, but it has been observed independently of such vitiation.

In cases of posterior obliquity or pelvic retroversion "the vulva is directed much more in front than usual, and the pubic symphysis presents a direction more or less approaching the vertical. The superior half of the sacrum has become parallel to the axis of the trunk, and the lumbar region is more or less without its posterior concavity—a flat back. Finally, the point of the coccyx is always found in the vertical position either at the level or beneath the summit of the pubic arch, and the last false rib is generally nearer the iliac crest than in the normal state."

In addition to these obliquities, Lenoir has given a description of lateral obliquity of the pelvis. According to Depaul, lateral obliquities are very frequently found in connection with rachitic skeletons, and even in cases of shortening, atrophy, or old luxations of the abdominal members.

Naegele, in referring to inclination of the pelvis, makes the following remarks: "Even when this inclination is normal, it quite often happens in cephalic presentation that the head presses upon the superior border of the pubic symphysis, and thus to some degree its entrance into the pelvic cavity is retarded. If in such cases the other conditions of the mechanism of labor are normal, this resistance is overcome soon by the efforts of nature, and delivery is accomplished without special difficulty. But if at the same time there is a more or less great disproportion between the head and the basin, the resistance presented by the anterior wall of the latter exerts a very injurious influence. This influence is much worse still when at the same time the inclination of the pelvis is too great. If, as frequently happens, an inclination exceptionally great coincides with narrowing of the pelvis, obstetric operations may be rendered much more difficult. For this reason it appears necessary in all cases where the head of the fœtus strikes against the pubic symphysis at entering the pelvis to have the woman lie in such a way that the lumbar vertebræ may be strongly flexed; that is to say, give her a half-sitting posture by raising the hips and the upper part of the trunk, or have her lie upon the side, her back bent forward, and the thighs strongly flexed upon the pelvis."

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[1] *Dictionnaire encyclopédique des Sciences médicales*, t. viii.

It has been advised, if deficient pelvic inclination hinders labor, to have the lumbar region elevated while the coccyx is placed lower.

II. ANOMALIES OF SIZE.—This division, which includes uniform increase and uniform lessening of the size of the pelvis, might also be distinguished as symmetrical anomalies in contradistinction to the third class, in which the anomalies are chiefly asymmetric.

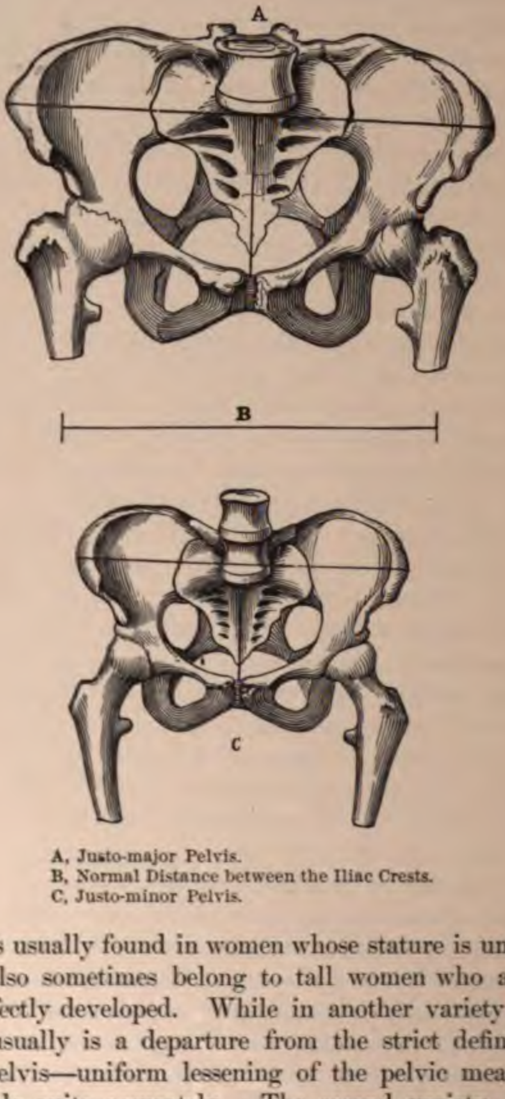
The subjoined diagrams, taken from Depaul, represent the justo-major and the justo-minor pelvis, while the line marked B is the measure of the distance between the iliac crests in a normal pelvis.

*a. The Justo-major Pelvis.*—In the pelvis marked A the distance between the antero-superior spinous processes was 28 centimeters, more than 11 inches, and that between the iliac crests 32 centimeters, more than 12 inches. The antero-posterior diameter of the inlet was 13 centimeters (5 inches), the transverse 16 centimeters (6.3 inches), and the oblique 15 centimeters (5.9 inches). The justo-major pelvis has been happily compared to the pelvis of a giantess found in a woman of ordinary size.

Schroeder held that the generally enlarged pelvis did not disturb the course of labor, not causing this to be rapid, and in short that it should not be regarded as pathological unless the same conditions were present as might be observed in the case of a normal pelvis. On the other hand, most obstetricians have taught that such a pelvis contributes to precipitate birth by the ampler canal through which the fœtus is transmitted. It is not necessary to repeat the statements previously made on page 693 as to the consequences to both mother and child which may follow too rapid delivery.

*b. The Pelvis Justo-minor, or the Generally-contracted Pelvis.*—This pelvis, as has been before stated, is characterized by a uniform lessening of its diameters: it is one of the most important anomalies of the pelvis. At least three varieties of this pelvis have been described. In the first the pelvis has the form characteristic of the sex, but seems to have been arrested in its development; the bones are frailer and smaller, and, while it is usually found in women whose stature is under the normal, it may also sometimes belong to tall women who are with this exception perfectly developed. While in another variety to be mentioned there usually is a departure from the strict definition of the justo-minor pelvis—uniform lessening of the pelvic measurements—this corresponds quite accurately. The second variety, the dwarf's pelvis, presents the usual characteristics of the normal female pelvis, only it is under size; there is a correspondence between the pelvis and the height, and the bones of the former correspond in their development as to size and firmness with those of the rest of the skeleton. The third variety is the masculine pelvis. This may have the exter-

FIG. 275.



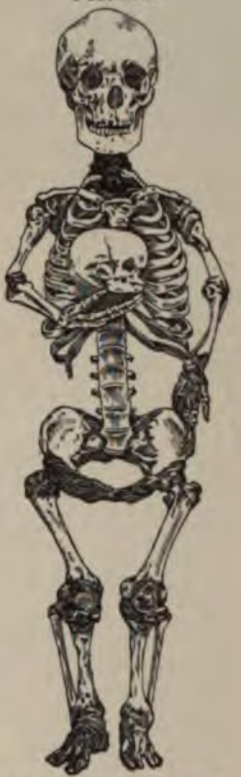
A, Justo-major Pelvis.
B, Normal Distance between the Iliac Crests.
C, Justo-minor Pelvis.

nal form of the female pelvis, but in some instances very strongly resembles the male. The bones are thick and strong; the sacrum is narrow; the ilia are straighter than normal; and the ischia are nearer each other. The external measurements may vary but slightly from the normal, and the contraction may not be uniform, but may concern the inlet, the cavity, or the outlet; in the latter case the pelvis becomes funnel-shaped.

The equally-contracted pelvis is not frequently seen; of its three varieties the masculine basin is the least, the dwarf's the most rare.

The causes of the justo-minor pelvis are generally obscure. In some instances the anomaly may result from rickets. This origin has been generally accepted. Zweifel states that he has seen one typical instance of generally equally-contracted pelvis which was caused by rickets, though this disease usually produces another abnormal form. Müller has mentioned the frequency of this pelvis in cretins and semicretins. Still, there remain the great majority of cases of this partial pelvic development which cannot be attributed to any constitutional disease, either hereditary or acquired.

FIG. 276.



Rachitic Woman[1] (Mütter Museum, College of Physicians, Philadelphia).

Before giving the diagnosis of the generally contracted pelvis, studying the mechanism of labor in such pelvis, and the treatment of labor then occurring, it is necessary to consider the means by which deformities of the pelvis are known—a subject the importance of which cannot be exaggerated.

Kleinwächter observes no error in diagnosis is so terribly avenged upon the mother and the child as one relating to contracted pelvis. It might be added that the vengeance falls, too, upon the obstetrician, for he can never escape self-reproach if, suitable opportunity having been his, he has failed to recognize the deformity in time to ward off at least some of its consequences, or possibly saving both mother and child by means appropriate to the emergency. A primigravida, for example, is in labor at the normal end of pregnancy; her form is apparently perfect, her health excellent, and there is not the least suspicion that the pelvis is abnormal. The first period of labor is somewhat longer than usual; the second is protracted until instrumental interference is demanded in her interest, if not in that of the child. One or more consultants come, and the forceps is tried, first one pattern, and then another, but all in vain. Meantime, serious inroads upon the patient's strength have been made, and disappointment at the delay in delivery almost brings her to despair. The next step is a craniotomy, the attendants now fully convinced that it is impossible for a living child to pass through the narrowed inlet. But before craniotomy and extraction of the mutilated fœtus can be completed she dies. Examination of the pelvis after death proves that the antero-posterior diameter of the inlet is barely two inches and a half. A timely Cæsarean operation would probably have saved both mother and child, or, this being refused, the mother's salvation might have been secured if the embryotomy had not been deferred until she was exhausted.

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[1] Fig. 276 is the skeleton of a rachitic woman and the skull of a fœtus that was removed from her by Cæsarean section. The operation was done by the late Dr. John B. Holmes of Charleston, S. C., assisted by Dr. West of North Carolina and Dr. Marsh of Maryland; the child was dead before the operation began, and the mother lived three days. As will be seen from the illustration, and as still better proved by the measurements, the pelvis was not only a dwarf's pelvis, but also a rachitic flat pelvis. The true conjugate was one inch and three-quarters, and the transverse four and a half inches, while at the outlet the corresponding diameters were three and a half inches and four and a quarter.—*Transactions of the Philadelphia Obstetrical Society*, 1879.

Diagnosis of Pelvic Anomalies.—This is made by the recognition and appreciation of signs which may be classified as probable and certain. The former are ascertained from the history of the patient, from her general appearance, carriage, walk, stature, etc., while the latter are sought by direct examination of the pelvis. In the history we learn as to sickness during infancy and childhood; as to the period when walking began; whether there was any bodily deformity observed at birth or any manifested since; whether any injury to the pelvic joints or dislocation of one of the femurs occurred in early life or in adolescence; whether one hip is higher than the other, or either femur is ankylosed. The vertebral column is examined for deformity, whether apparent or latent; if it presents a deforming curvature, the period of its first manifestation is inquired, for such curvature, if manifested first in infancy, is most probably caused by rickets; and this origin will be confirmed by examining the lower limbs as to being notably curved. In this case the pelvis is in almost all cases deformed. But if the spinal curvature began during adolescence, the cause is not rickets and the pelvis may be normal. The woman is lame, and the first origin and cause of that lameness should be ascertained.[1]

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[1] Peu[1] makes the following statement, which is interesting as one of the earlier obstetric references to deformed pelvis, and as also showing that this wise observer could not be beguiled by beauty, intellect, wealth, and social position into marrying a young lady who he believed from her lameness had a deformed pelvis: "I remember

[1] *La Pratique des Accouchemens*, Paris, 1695.

If the woman has previously been delivered, we inquire as to whether the labor was natural or artificial, whether the child was born living or dead, and in case of instrumental delivery what means were employed. If possible, too, ascertain further as to the cause of the difficulty in a previous labor or labors, for that may have been from an abnormal presentation or from excessive size of the child. It should also be remembered, on the other hand, that though the first labor may have been spontaneous, there might still be some narrowing of the pelvis, which would render subsequent ones difficult from the increasing size of the children.

*Certain Signs.*—As before stated, the positive proofs of pelvic deformities are obtained by measurements of the pelvis, or pelvimetry. These measurements are made by an instrument called a pelvimeter, by an ordinary tape-measure, and by the hand or fingers. The pelvimeter most generally employed is that of Baudelocque or that of Martin: the latter instrument has the recommendation of being quite portable, and is represented in use in Fig. 277. In using the pelvimeter the woman should be lying upon her back, and the lower portion of the body exposed, or at least covered with only one thickness of very thin material. Before beginning to measure with the pelvimeter, the obstetrician applies his hands externally to the pelvis, ascertaining whether one hip is higher than the other, finds out whether there is decided narrowing of the hips, the thickness and size of the iliac bones, the depth of each iliac fossa, the breadth and curvature of the sacrum, and the height of the pubic joint. Next the external measurements are made: first, the distance between the anterior superior spinous processes of the iliac bones, one of the knobs of the pelvimeter touching the one process, and the other placed upon the process of the opposite side: this is usually 25 centimeters, or about 10 inches; second, the greatest distance between the iliac crests at their external margin is similarly ascertained: this diameter is 28 centimeters, or 11 inches.

that at the time of the second Paris war, having recently settled, it was proposed to me to marry a beautiful young lady, rich, very spirituelle, and one whose father I greatly honored; but she was small and lame in one lower limb. The consequences of the lameness which I apprehended prevented me from making this alliance. One of our aspirants in surgery, braver than I, or perhaps more unfortunate, fell in love with her and married her. Unfortunately, she became pregnant. Shortly her abdomen touched the ground, and she fell from the slightest misstep. Her frequent falls compelled her to lie in bed. Her child died, and she also when about eight months pregnant."

Further reference to lameness as indicating deformity is given by Dionis.[1] He has remarked that "the lame who have one of the hip-bones higher than the other sometimes have great difficulty in labor, because the basin formed by these bones is not exactly round, and the infant is obliged to redouble its efforts in order to go through the passage."

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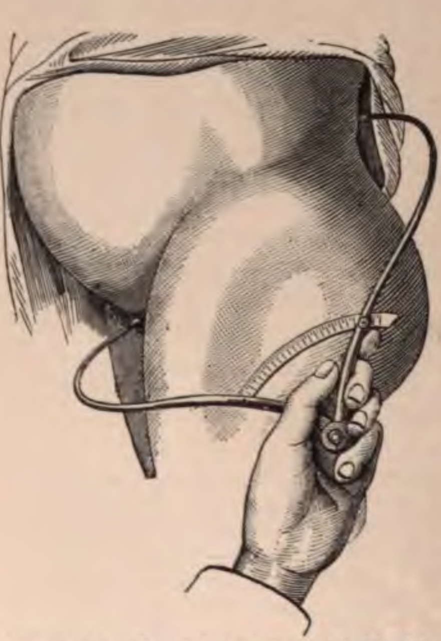
[1] *Traite général des Accouchemens*, 1718.

The third measurement made is that between the great trochanters; this in case of a normal pelvis is 31 centimeters, or 12¼ inches. If these three diameters are normal, we know that there is no lateral narrowing of the pelvis. The fourth measurement is taken from the spinous process of the last lumbar vertebra to the middle of the anterior surface of the pubic joint. This diameter, known as the external conjugate or the diameter of Baudelocque, enables us to approximate the probable diameter of the pelvic inlet, or the true conjugate; the former measures 20 centimeters (7.9 inches), and by deducting from it 8 centimeters (3.1 inches), the latter is approximately ascertained: such deduction is supposed to correspond with the combined thickness of the pelvic walls anteriorly and posteriorly. But the only absolutely certain fact which we reach by measuring this diameter is, that if the distance be notably diminished the true conjugate is less than normal.

The circumference of the upper or false pelvis is learned by applying the end of an ordinary tape-measure to the spinous process of the last lumbar vertebra, and carrying the tape along the iliac crest of one side, and thence to the median line at the pubic joint; similarly, the other half is measured, the results added, and thus the entire circumference is ascertained. Evidently, if the one measurement is greater than the other, the pelvis is asymmetrical. So too such asymmetry may be determined by comparing the two external conjugates, or, still better than the latter, measuring the distance of the trochanter of one side to the middle of the iliac crest of the other, and *vice versâ*. The normal circumference of the false pelvis is 90 centimeters = 35.5 inches.

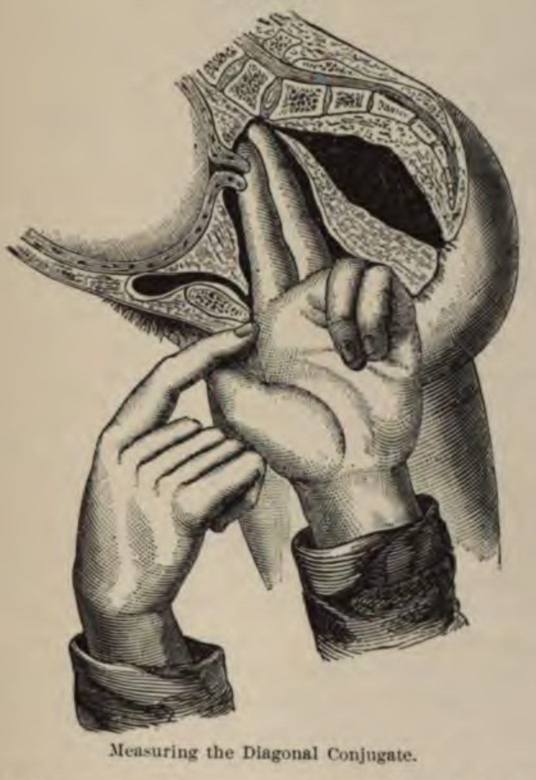
FIG. 277.



Measuring the External Conjugate with Martin's Pelvimeter.

Next, the diagonal conjugate—that is, the distance from the lower margin of the pubic joint to the promontory of the sacrum—is found usually by means of one or two fingers. In the following illustration the index and medius of the left hand are extended, the thumb abducted, and the third and fourth fingers folded upon the palm; the extended fingers are carried up and backward in the pelvic cavity until the promontory is touched; then, still keeping up this contact, the hand is brought upward until its lateral margin, just below the index finger, comes in contact with the subpubic ligament. Next, this last point is marked by the nail of the index finger of the right hand; then the left hand is withdrawn, and the measurement made from this mark to the tip of the finger. Kleinwächter holds that the introduction of the index and medius at the same time ought not to be permitted, except perhaps in the case of a multigravida, because the stretching of the soft parts by two fingers will cause pain; but he adds that in very difficult cases the half or the whole hand may be used. There is no great difficulty in reaching the promontory if the pelvis is normal, and of course it is more accessible if the true conjugate is shortened.

FIG. 278.



Measuring the Diagonal Conjugate.

If the basin be normal the true conjugate may be found by subtracting 15–16 millimeters ($\frac{5}{10}-\frac{6}{10}$ of an inch) from the diagonal conjugate. "It is evident that this subtraction will vary according to the angle which the true conjugate makes with the pubic symphysis, and as to the height of the symphysis. It is increased with the obtuseness of the angle and with the elevation of the symphysis. Hence, with the various pelvic deformities the subtraction will vary. Though the height and thickness of the symphysis may be ascertained, but not the angle which it forms with the true conjugate, the latter can only be estimated, and hence slight errors may be made. Nevertheless, with proper skill the length of the true conjugate may be determined within a few millimeters, and the error is so slight that it may be regarded as of no importance."

Measurements of the diameters of the pelvic outlet are of much less importance; nevertheless, they may be required in some cases. To obtain the antero-posterior diameter, the woman lies, for example, upon her left side, and the obstetrician with the thumb and index finger of the right hand—the former externally, the latter in the vagina—finds the sacro-coccygeal joint, and includes it between the thumb and finger. The end of the finger is fixed at that point, while the mass of the finger is carried forward and upward until its lateral surface is brought against the subpubic ligament, and while held firmly in that position is marked by the nail of the index finger of the other hand, as in ascertaining the diagonal conjugate. Upon withdrawing the finger the distance from the mark to the tip is measured, and this will give the desired diameter. Breisky places one of the knobs of the pelvimeter externally at the sacro-coccygeal joint, while the other is put at the lower margin of the pubic joint; now, subtract from the measure thus obtained 1 to 1.5 centimeters, and we then have the antero-posterior diameter. Breisky recommends for measuring the transverse diameter of the pelvic outlet Osiander's pelvimeter. The knobs are placed upon the ischial tuberosities, and from the measure thus obtained of the intervening distance between the tuberosities, 1–2 centimeters must be subtracted for the thickness of the soft parts. Frankenhäuser's method is to place the thumbs, their nails being directly opposite, upon the most prominent surface of the inner margin of the ischial tuberosities, and then with Osiander's pelvimeter measure the distance between the nails.

Barbour[1] states that the transverse diameter of the outlet is best estimated by Chantreuil's method: "Place the patient in the genupectoral posture or in the lithotomy posture, though the former facilitates the measuring; pass the index fingers into the vagina, and turn them back to back so that the pulp of the finger rests on the inner surface of the ischial tuberosities; an assistant lays the points of the calipers on the palmar surface of the fingers just outside the vulva, the distance of which apart corresponds to the inside measurement between the tuberosities. This allows us to use the ordinary calipers."

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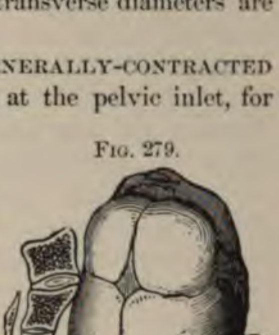
[1] *Spinal Deformity in Relation to Obstetrics.*

*Diagnosis of the Justo-minor Pelvis.*—The distances between the iliac anterior superior spinous processes and between the iliac crests are found less than normal in all cases, an exception being made for the masculine pelvis, for in it, in consequence of the increased thickness of the bones, these differences may be very slight or even absent. The pelvic circumference is lessened, as is also the true conjugate. Contraction at the outlet will be suggested by the apparent approximation of the ischial tuberosities and spines, and be confirmed by ascertaining that the antero-posterior and the transverse diameters are under the normal.

LABOR, AND ITS TREATMENT IN THE GENERALLY-CONTRACTED PELVIS.—Labor begins with the fœtal head at the pelvic inlet, for there is not, as there is in the majority of primigravidæ having a normal pelvis, descent of the head into the pelvic cavity during the last weeks of pregnancy. The resistance of the lessened inlet compels strong flexion of the head upon the chest, and thus, with the occiput below, the head enters, the biparietal diameter corresponding with the conjugate, and the suboccipito-bregmatic with the transverse; the sagittal suture at first probably lies in the transverse diameter. The uniformity of the pelvic contraction shows itself by the strong resistance to any lessening of flexion, there being such constant and strong pressure upon the frontal arm of the head-lever.

FIG. 279.



Marked Flexion of the Head entering a Generally-contracted Pelvis.

Zweifel, in describing the mechanism of labor in generally contracted pelvis, says the sagittal suture may sometimes be in the transverse or in the oblique, or even in the antero-posterior, pelvic diameter, and hence the child's head becomes elongated. This elongation, however, cannot be in the occipito-mental diameter, but rather in that described by Budin as the maximum diameter, for the squamous portion of the occipital bone is pushed under the parietal bones, this movement being permitted by the cartilaginous connection between it and the basilar portion. So, too, the equally strong compression to which the head is subjected on all sides compels overriding of the frontal by the parietal bones, while the posterior of the latter overrides the anterior. The caput succedaneum is large and long, even in some cases protruding from the vulvar opening while the head is in the cavity. Anterior rotation of the head does not occur, but the occiput passes out over the perineum.

From the head remaining so long at the pelvic brim while strong uterine contractions are going on, there is danger of injury to some portions of the lower uterine segment, resulting in subsequent inflammation, or actual perforation by long-continued attrition may result. So, too, exhaustion may come on to such degree that the life of the mother is imperilled, the uterus falling into a state of atony. The long continuance of the labor carries danger to the fœtus, and so too injury may result from the strong compression of the fœtal head.

Delay in rupture of the membranes until the os is fully dilated, descent of the occiput rather than of any other part of the fœtus, moderate size of the fœtus, yielding character of the bones of the head, and on the part of the mother a slight degree of pelvic contraction and vigorous uterine and voluntary action, are to be regarded as propitious, the labor under these circumstances usually terminating favorably for both mother and child.

On the other hand, early rupture of the membranes, great size of the child, unyielding nature of the cranial bones, and unfavorable presentation—as, for example, of the pelvis, usually a knee or foot descends first because of the difficulty of the pelvis entering the inlet—of the brow, or of a shoulder, will make the prognosis unfavorable.

But the most important condition to be considered is the degree of pelvic contraction, and this largely governs not only the prognosis, but also the treatment.

If the obstetrician recognizes in case of general pelvic contraction in a pregnant woman that the true conjugate is under 9 centimeters (3.5 inches), he will be not unduly cautious should he induce labor at eight months; and the obligation to do this becomes positive if the diameter is 8 centimeters (3.1 inches). If the true conjugate falls below 8 centimeters, the selection must be made between embryotomy and the Cæsarean section. How low it must fall to render the latter imperative is unsettled. Some make that limit two inches and a half—it is rare that in general pelvic contraction the true conjugate is lessened this much—while others reduce it much lower. Wasseige regards the limit of delivery through the natural passage 4.5 centimeters (or 1.6 inches), while Kleinwächter[1] states that if the length of the true conjugate is less than 6.5 centimeters (2.5 inches), the Cæsarean section cannot be avoided. Barnes holds that craniotomy finds its application where labor at term is obstructed from pelvic contraction, conjugate ranging from 3.25 inches—3.50 as a maximum—to 1.75 or 1.50 as a minimum. Zweifel teaches that with a conjugate below 6–5 centimeters (2.37–2.12 inches) there is absolute impossibility of removing the child except by the Cæsarean operation. With this conflict of great authorities the obstetrician may well hesitate. But, on the other hand, considering the great improvements in the Cæsarean operation, leading to a greatly lessened mortality, such operation, the mother consenting, will be selected if the conjugate is 2.5 inches or less.

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[1] *Des Operations obstetricales.*

The forceps is not applicable in general contraction of the pelvis until the head is completely moulded. If the obstetrician is misled into resorting to this instrument before this moulding, this adaptation of the head to the narrow canal it is to traverse, is accomplished, the error is avenged most severely. The pelvic bones or joints may be seriously injured, the soft parts torn; a dead child is delivered, and the mother is liable to perish subsequently. So, too, podalic version is not indicated if the head presents, for extraction after turning cannot be effected soon enough to save the child's life; the head must be moulded to the passage in a few minutes—a process which Nature's forces require hours to accomplish. Further, if craniotomy should finally become necessary, the difficulties of the operation are increased because of the head coming last. Another objection to delivery by podalic version is the almost inevitable ascension of the arms caused by the pelvic contraction. In those cases where the contraction is chiefly at the inlet the mechanism of labor after the head has entered the cavity is the same as in a normal pelvis; and then, too, the treatment corresponds.

III. ANOMALIES OF THE PELVIC FORM, OR ASYMMETRICAL CHANGES IN THE PELVIS.—Two divisions of this class are made, the first including changes in the depth of the pelvis: *a.* That in which the vertical diameters of the pelvis are increased, without a corresponding change in the horizontal. Such change increases the depth of the pelvis, but alone does not, to an important degree, modify the course of the labor; the latter will be longer, and in some cases its protraction may require the use of the forceps.

*b.* The second class embraces those pelves whose depth is lessened. But this change is in almost all instances associated with pelvic deformities. If occurring independently, all the horizontal diameters being normal, other things being equal, the duration of labor is lessened.

The second division is much more important, and includes those changes which deform, render asymmetrical, or vitiate the pelvis. It embraces three varieties: 1, those characterized chiefly by shortening of the antero-posterior diameter; 2, a like change in the transverse; and, 3, the same in the oblique diameter.

The following subdivisions are made of these three classes of pelvic deformities. These subdivisions are the same as those adopted by Zweifel:

I. Pelves chiefly contracted in the antero-posterior diameter:
  *a.* The flat pelvis;
  *b.* The rachitic flat pelvis;
  *c.* The generally contracted flat pelvis;
  *d.* The spondylisthetic pelvis;

*e.* The pelvis flattened by double luxation;
*f.* The lumbo-lordotic pelvis.

The last originates in lordosis of the lumbar vertebræ, which is compensated by a deeply situated kyphosis. In consequence of the lordosis the lumbar vertebræ may project over the pelvic entrance, causing the deformity known as pelvis obtecta, or roofed pelvis. In the osteomalacic pelvis, to be described in the next class, there is also considerable contraction in the antero-posterior diameter.

II. Pelves chiefly contracted in the transverse diameter:
*a.* The osteomalacic pelvic;
*b.* The ankylotic transversely contracted pelvis;
*c.* The kyphotic transversely contracted pelvis.

In *b* and *c* the narrowing is only in the pelvic outlet.

III. Pelves chiefly contracted in their oblique diameter:
*a.* The ankylotic obliquely contracted pelvis;
*b.* The coxalgic pelvis;
*c.* The scoliotic pelvis.

Neoplasms originating in the pelvic walls constitute a final class of pelvic contractions.

*The Simple Flat Pelvis.*—This pelvis may be found in women who present no other anomaly of form which would awaken the slightest suspicion of its presence. They are usually of normal stature and apparently of perfect development. There is no history of disease of the bones in infancy or childhood, or of injury to spine or pelvis or lower limbs in adolescence. How often has this anomaly led to the most deplorable results in childbirth! Even in Europe this pelvis is found a little more frequently than the rachitic, while the American obstetrician will meet with it oftener than any other pelvic anomaly, and thus forewarned ought to be forearmed.

The cause of the deformity is not readily ascertained. The latter consists essentially in an approximation of the sacral promontory to the anterior pelvic wall, and this sinking of the sacrum has been attributed to walking too early, to sitting too long at a time in infancy, and also simply to the weight of the body, though neither of the other causes may be justly adduced. Still another explanation of the etiology has been suggested—the carrying of heavy weights in childhood; but the occurrence of the anomaly in women who were never subjected in childhood to severe toil renders necessary the explanation that has been given—viz. the simple weight of the body may cause the deformity.

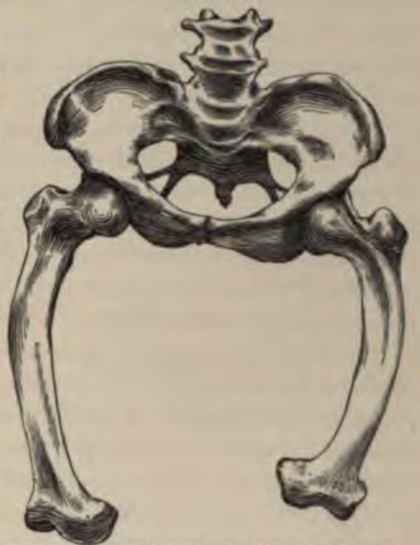
The descent of the sacrum is without any rotation upon its transverse axis, and the approximation of this bone to the pubic bones, and the shortening, involve only the antero-posterior diameter of the inlet, or if those of the cavity and outlet are lessened the diminution is very slight. The descent involves strong tension upon the ilio-sacral ligaments, which would cause separation of the iliac bones if it were not for the resistance of the pubic joint; and the consequence is that the transverse diameter undergoes slight increase and the pubic joint is brought nearer the sacrum.

Schroeder states that in very rare cases a flattened pelvis is also narrowed in the transverse diameter of the outlet. In a practical point of view, this is a very important complication of the flattened pelvis. Sometimes the articulation of the first with the second sacral vertebra, which remains unossified, forms that which is called a double promontory; that is to say, the two vertebræ meet at an obtuse angle posteriorly, and the articulation makes in contracting a projection in the pelvic cavity.[1] If a line be drawn from this crest to the pubic symphysis, it is as short as, or even shorter than, the true conjugate itself, and, as this anomaly has an essential obstetric importance, it is necessary to count it in pelvic measurement.

The diagnosis of the flat, non-rachitic pelvis is readily made by measuring. The transverse measurements are normal or slightly increased; the circumference is normal or slightly decreased, but the two sides of the upper pelvis are symmetrical; the external conjugate is always diminished, and by this diminution, combined with that of the diagonal conjugate, the true conjugate is found, which of course is less than normal, and in the great majority of cases at least 8 centimeters (3.1 inches).

*Rachitic Flat Pelvis.*—This deformity results from pressure upon the base of the sacrum chiefly, causing not only descent of this bone, but also a partial anterior rotation upon its transverse axis; thus the promontory is brought nearer the pubic joint, and the true conjugate necessarily shortened. In a flat rachitic pelvis in the Museum of Jefferson Medical College I find the following measurements of the pelvic inlet: Oblique diameter, 5 inches; transverse, 5½ inches; and true conjugate, 3 inches. The meas-

FIG. 280.



Flat Rachitic Pelvis (Mütter Museum, College of Physicians, Philadelphia).

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[1] Schroeder. Nevertheless, Zweifel remarks, in reference to the name given this pelvis, we use the expression plain, *einfach*, in contradistinction to rachitic. By this term Michaelis first expressed the difference between a single and double promontory.

urements of the outlet are—anterior-posterior, 3¾ inches, and the transverse 4. The depth of the pelvis at the pubic joint is 1¼ inches, at the sides 2¾ inches.

Rickets is a disease occurring in infancy or early childhood, chiefly characterized by a disorder of nutrition and development of bony tissue, the disorder involving various deformities of the skeleton, swelling of the epiphyses, bending or fractures of the diaphyses, important changes in the shape of the pelvis, and frequently curvatures of the spine. While in almost all cases it is a disease of extra-uterine life, yet there have been instances in which it occurred in utero, probably the first recorded one being given by Glisson in 1650. In 1645 a committee of eight physicians was appointed by the College of Physicians of London to study a disease known in popular language as the rickets, which appeared to be quite general in the south-west of England. The name, though poorly expressing the condition, remains, but it is quite as suitable as rachitism, which is now used as a synonym.

The special nature of the disease consists in the formation of the cartilaginous basis of bone, but the calcareous deposits fail. It is a disease especially of poverty, and is found most frequently in the large cities of the Old World, where the poor abound and the children of the poor often so greatly suffer from want of sufficient food, fresh air and sunshine, and proper clothing. Arnott[1] speaks of its being frequent in India, though he also states that, so far as his experience goes, osteomalacia is relatively to rickets and also absolutely more common in India than in Europe.

The child suffering from rickets does not walk as early as healthy children, but is much of the time in a sitting posture; the pressure of the body's weight causes not only the changes in the position of the sacrum previously stated, but also, through the resisting tension of the ilio-sacral ligaments, drawing of the innominate bones, so that they would separate if it were not for the resisting pubic joint; this separation being impossible, the bones yield, and hence the transverse diameter of the inlet is increased, "just as a long bone may be fractured in the shaft by a force applied at one end, the other end resisting." In consequence of the weight of the body resting upon the ischial tuberosities, and by the action of muscular traction, the former are more widely separated, and also the pubic rami, and the pubic arch is broadened.

If the child walks during the disease, the pelvic deformity is greatly increased, there being superadded the changes caused by pressure upon the acetabula. "The parts adjacent to the acetabula are pressed into the basin by the resistance of the heads of the femurs, and thus the sacro-cotyloid diameters are lessened. In consequence of the approach of the ilio-pubic tubercles the ischial spines are pressed in the pelvis;

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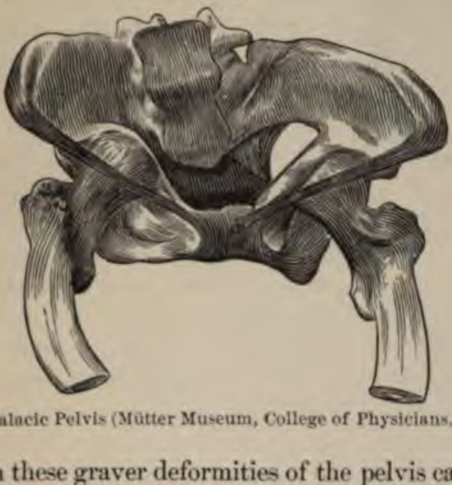
[1] *Transactions of the Edinburgh Obstetrical Society*, vol. x.

the approximation of the former causes a beaked protrusion of the pubic joint." In the highest degree of the deformity the lumen of the pelvis is almost closed, and with bending of the sacrum and iliac bones the pelvis may take a triangular form, and is known as the pelvis triloba, or the pseudo-osteomalacic pelvis.

FIG. 281.

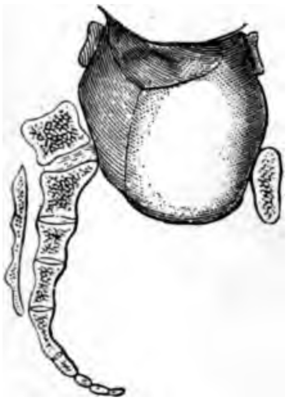


Pseudo-osteomalacic Pelvis (Mütter Museum, College of Physicians, Philadelphia).

Turning from these graver deformities of the pelvis caused by rickets, we will now consider the diagnosis of the simply flat rachitic pelvis. The history of rickets is learned, and many of its obvious consequences in other parts of the skeleton may be present. The distance between the antero-superior iliac spines is equal to, possibly exceeds, that between the iliac crests; the external conjugate is always lessened; the true conjugate is shortened; in some instances the second sacral bone protrudes into the pelvic cavity, making what is called the false promontory, and this may be more prominent than the true, when, of course, it becomes one of the terminal points of the conjugata vera. The antero-posterior and transverse diameters of the outlet become unusually large in comparison with the contraction at the inlet.

*The Mechanism of Labor in the Simple Flat and in the Rachitic Flat Pelvis.*—In consequence of the narrowing of the pelvic inlet in the conjugate, the head of the fœtus not only does not enter the pelvic cavity, as is the rule in the last weeks of pregnancy in primigravidæ, but it is turned aside at the brim, and hence the proportion of transverse presentations is increased. Another factor in causing such malposition of the fœtus is found in multigravidæ in the relaxed abdominal wall, which permits anterior displacement of the uterus. If the pelvis be below, its descent through the narrowed aperture does not occur, but the feet are prone to enter. Supposing the head to be at the inlet when labor begins, this takes a transverse position; that is, the sagittal suture instead of being oblique lies directly from one side toward the other of the pelvis. Resistance to the descent of the occiput compels a partial deflection, and the anterior and posterior fontanelles are in about the same pelvic plane; thus the transverse diameter of the fœtal head is in the pelvic conjugate, and the occipito-frontal in the pelvic transverse. But in this accommodation the anterior parietal is somewhat in advance of the posterior, and therefore the sagittal suture approaches the sacral promontory. (See Fig. 282.)

FIG. 282.



Head passing through the Inlet in Flat Pelvis.

The anterior parietal bone, pressed against the anterior pubic wall, becomes the fixed pivotal point around which a partial revolution of the posterior parietal occurs in the descent until the promontory is cleared. But in order that this descent can occur, the transverse diameter of the head must be lessened; this lessening is in part accomplished by the lateral margin of the posterior parietal passing under the corresponding part of the anterior parietal. In some instances the revolution is reversed; that is, the posterior parietal is fixed at the promontory, while the anterior moves down; then the relations of the parietals are changed, in that the posterior overrides the anterior. Further diminution of the head transversely may be effected by indentation, deep depressions, or even fractures or fissures of the revolving parietal. After the head has passed the inlet the subsequent mechanism is the same as in normal labor, and often then the delivery is more rapid from the ampler space furnished by the cavity, and especially by the outlet in the pelvis flattened by rickets, as has been previously stated.

In exceptional cases the sagittal suture is placed so near the pubic or the sacral wall of the inlet as to make what has been termed a parietal presentation; and if this presentation is not rectified delivery is impossible without craniotomy. Descent of the frontal bone first may occur in great narrowing; then the two halves of the bone play a corresponding part to that of the parietals in relation to the pubic and the sacral wall of the pelvis. Whether parietals or the frontal halves pass the strait first, the posterior bone has a distinct pressure mark from its being so strongly forced against the promontory.

In case the pelvis was originally very wide in its formation and the sacral promontory projects greatly, giving the pelvic inlet somewhat the form of the figure 8, the head if very small may pass through one side of the inlet, usually the left side because of the greater frequency with which the occiput is found upon that side of the pelvis; and in consequence of this aperture usually being round, the mechanism is that described as occurring in the justo-minor pelvis. In pelvic presentation one or both feet usually descend first; if the contraction is slight, the body passes through it without serious difficulty; then the head may pass also—of course it must be in a transverse position for this passage—flexion being continued; the posterior parietal bone suffers from pressure in passing the promontory. In more decided narrowing departure of the chin from the chest is observed.

Complications of labor in narrow pelves are transverse presentations, prolapse of the umbilical cord, and failure of vigorous uterine contractions. The same danger of injury to some parts of the lower part of the uterus, bruising or perforation from the pressure of the fœtal head, that were mentioned in describing labor in the justo-minor pelvis, may be present here. Nevertheless, if the contraction of the pelvis be only moderate, obviously the prognosis is better than in that pelvic anomaly; for in the latter the struggle is continuous during all the passage of the head through the bony pelvis, while in the other the narrowing is of only a part of the canal; and this narrowing, too, has a partially compensating increase in size of the diameter at right angle to the one shortened. If the presentation is favorable, the child not of abnormal size, and uterine action is vigorous, the result may be regarded hopefully. Of course, conditions opposite to those stated would be unfavorable. So too, if the woman has previously given birth to children, the difficulty in delivery may be notably increased—first, by the probably greater size of this child, and, second, by the lessened vigor of the uterine muscle.

In the management of the labor care should be taken to keep the membranes unruptured until the os is dilated, and hasty intervention while the head is being moulded to pass through the narrowed inlet must be avoided. If nature is unable to effect the passage of the head through the inlet, and indeed the former remains above it, resort to the forceps is not indicated, but podalic version. In regard to the former means, Zweifel observes that the application of the forceps to the movable head is not impossible, but to seize it firmly is purely accidental; an application of the blades over the parietal bones is absolutely impossible; and even if the head were thus grasped, it could not be drawn through the conjugate. Version comes only in those cases in which the forceps cannot be used; and even then the question, as Schroeder has framed it, is, Shall we turn, or wait? "Whenever we perform version in contracted pelves we decide in favor of this operation without knowing, in case this is not done, how the head would enter the true pelvis and how it would pass through. This renders the question as a practical one so difficult, and will probably thus keep it for a long time, probably for ever."[1]

There must also be borne in the mind of the obstetrician that, if he resorts to turning, it is essential to the life of the child that its transmission through the narrowed inlet must be rapidly accomplished—that there is in effecting this danger of injuring the members or other parts of the fœtus, and, though the child is delivered living, it may be maimed, its brain injured either with or without fractures of cranial bones: it is not so much mere turning the child that presents serious difficulty or danger, but the following extraction.

In regard to those cases of such narrowing that even a mutilated child cannot be transmitted, nothing need be added to what has been previously stated under the head of the justo-minor pelvis.

*Generally-contracted Flat Pelvis.*—In this form there is a greater degree of descent of the sacral promontory than is found in the generally-contracted pelvis, and the entire deformity rarely occurs except as a consequence of rickets. Not only all the pelvic diameters are below the normal, but the true conjugate is especially shortened.

*The Spondylolisthetic Pelvis* (from *σπονδῦλος*, probably, more correctly, *σφονδῦλος*, vertebra; and *ολισθεσις*, a slipping or gliding).—This deformity arises from a gliding or slipping forward of the last lumbar vertebra, so that it no longer rests upon the upper surface of the first sacral vertebra completely, but only partially; or even, in an excessive degree of spondylolisthesis, the posterior wall of the body of the former vertebra may be fixed to the anterior wall of the body of the latter, a synostosis occurring. Sometimes, indeed, the lumbar vertebral column glides down to the body of the second sacral vertebra. The lumbar vertebræ thus sinking, lordosis results, and the lower edge of the fourth lumbar vertebra, or the union between the third and fourth, or even that between the second and third, is opposite the pubic joint.

This pelvis was first described by Rokitansky. The question as to the cause of the deformity has been much discussed. From the firmness of the transverse processes of the normal vertebræ, it would seem impossible for a dislocation of one of the bodies to occur; and the view generally held as to its origin in the majority of cases is that a fracture of the vertebral arch anterior to the articulating processes—this fracture caused by a fall upon the sacrum—and hence dislocation, becomes possible. "If a person should thus fall with the body bent forward, the sacrum being fixed at the moment of the accident, the force will mainly act upon the body and arch of the last lumbar

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[1] For the most important discussion in this country of the relative merits of versions and of forceps in contracted pelves, see *Transactions of the Philada. Obstetr. Society*, 1874-75. The discussion was between Drs. Goodell and Wilson.

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above the sacrum; by the shortening of the abdomen, its contents sinking so much between the ilia; by the peculiar "rocking gait" of the pregnant woman; by the absence of any history or present manifestation of rachitis or of osteomalacia; by an account of a fall such as would result in fracture of the arch of the fifth lumbar vertebra; but, above all, by internal examination, counting the bodies of the sacral vertebræ, and recognizing the projecting lumbar vertebra by finding the sacral vertebræ complete, and by the absence of the alæ in this, which belong to the first sacral. In Olshausen's case the bifurcat
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*The Pelvis Flattened from Bilateral Dislocation of*

—Whether the double dislocation be congenital or occur early in childhood, the heads of the femurs pressing above and posteriorly to the acetabula, great traction is exerted upon the round and upon the ilio-femoral ligaments; the muscles of rotation passing from the inner side of the pelvis to the femur, the obturators, and gemelli, are also made tense. Hence traction in a transverse line at the pelvic outlet and partial eversion of the pelvic outlet. By the tension of the ilio-femoral ligaments passing from the capsule to the anterior inferior spinous process, and in consequence of the place of support of the trunk, the heads of the femurs, being placed farther back, the centre of gravity is thrown anterior to the plane of support; continual care is necessary to prevent falling forward, and this is exerted by the dorsal muscles drawing the body backward, the consequence of which is the inclination of the pelvis is lessened, and there is a lumbar lordosis. Tension upon the pelvic ring causes increase in the transverse diameter of the inlet and flattening of the pelvis, with necessary shortening of the conjugate; the latter diminution is also increased by sinking of the sacrum. Not only the conjugate is lessened, but usually the corresponding diameters of the cavity and of the outlet, though, according to Kleinwächter, this lessening becomes less at the outlet in consequence of the recession of the lower part of the sacrum, while, on the other hand, it may be that, resulting from tension upon the ligamentous connections between the ischial tuberosities and spines upon the lower portion of the sacrum, the latter is drawn forward, and then there necessarily follows lessening of the antero-posterior diameter of the outlet.

The true conjugate rarely falls below nine centimeters, but in some it has been reduced to seven. The characteristics of this pelvis are, in addition to the lessened conjugate, the increase of the transverse diameter, the fact of the double luxation, the greater breadth of the pubic arch, the lessened pelvic depth, and the flattening of the pelvic inlet. The diagnosis in the living subject is greatly facilitated by observing the duck-like gait. The anomaly of the pelvis, if we know the peculiar walk of those having such a basin, Zweifel states, can be diagnosed at a distance of two hundred steps.

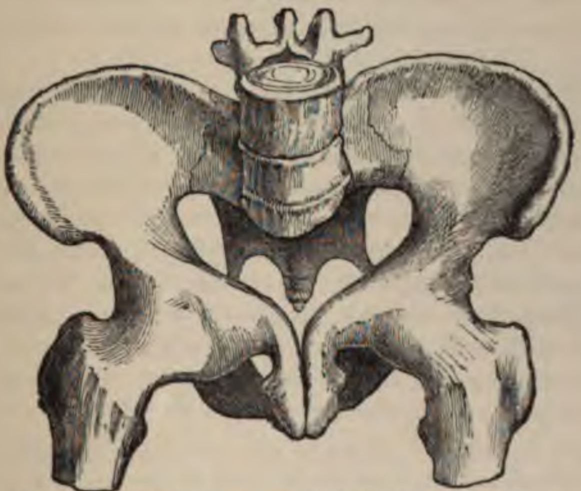
This pelvic deformity is quite rare; according to Kleinwächter, only nine of such pelves have hitherto been observed. The labor usually ends favorably both for mother and child; after the head once passes the inlet the progress is quite rapid.

*The Second Class, that in which the Pelvis is chiefly Narrowed in its Transverse Diameter.*

(*a*) *The Osteomalacic Pelvis.*—Osteomalacia (from **οστεον**, bone, and *μαλακος*, soft—mollities ossium, softening of the bone) is a disease of which the essential cause is a diminution of the earthy salts of the bones, this diminution being such that these salts are two, three, or even five times less than normal, and of which the most marked results are changes in the forms of the bones in consequence of their great flexibility. It is not a disease belonging exclusively to adult life nor to the female nor to childbearing. Nevertheless, the statistics of Collineau indicate very clearly the frequent origin of the disease in consequence of changes of the organism caused by pregnancy. He found only 14 of 43 women suffering with osteomalacia who had never been pregnant, and of the other 29, 14 who had had from four to ten pregnancies, 6 one to three, and 4 who had been pregnant but once. Nevertheless, as these statistics prove, the majority of cases of the disease are connected with pregnancy. It may appear during gestation or in the puerperium; once begun, the disease is aggravated by succeeding pregnancies, especially if the intervals are short.

It is impossible to satisfactorily explain the anomaly of nutrition which is essential to the disorder. "While true that the disease has never been observed in women comfortably situated in life, even the lack of good nourishment, miserable and damp dwellings, a diet exclusively of potatoes or of rice, cannot be regarded as the absolute cause of the disease, though the conditions just stated are undoubtedly predisposing causes. If deficient nourishment of the bones in the large majority is the sole cause, so that the bones, losing their earthy elements, are softened, then osteomalacia would be much more frequent. A fact that is inexplicable is, that the disease occurs usually only rarely and sporadically, but in some countries very frequently, so that it may

FIG. 284.



Osteomalacic Pelvis, showing the beak-like shape of the pubes.

be called endemic; thus it is found on the banks of the lower Rhine and in the adjacent valleys, in East Flanders, and on the plains of the Po." The fact of its frequently being seen in India has previously been stated.

The changes in the spinal column and in the pelvis result from softening of the bones affected by pressure and by traction. The spinal column, corresponding to its normal curvatures, is pressed by the weight of the body, and hence follow kyphoses, kypho-scolioses, and lordoses. The weight of the body causes by its pressure upon the sacrum pushing of the promontory downward and forward, and the sacrum draws anteriorly the posterior halves of the ilia, so that they are bent. The sacrum is narrowed, especially from lessened expansion of the alæ, and it is also bent forward. The pressure from the femurs forces the acetabula and adjacent parts inward and upward, so that the pubic joint and horizontal rami are pressed forward, the rami becoming parallel and proximate, so that the ilio-pectineal eminences are adjacent. The illustration given shows the beak-like projection of the pubic joint —pelvis rostrata. The pubic arch almost entirely disappears, and while the antero-posterior diameter of the inlet may be increased, the available space is seriously lessened. The pressure upon the acetabula always makes the outlet less than the inlet.

In making the diagnosis of deformity of the pelvis from osteomalacia, the history is of great importance; for example, the period when the disease was first manifested—just following pregnancy; the severe pains felt—tearing and drawing, mistaken in some cases for violent rheumatism. The patient's walk is characteristic, for in consequence of the approximation of the acetabula the femurs are brought near, and she is compelled at each step to turn on one foot while the other is thrown around and in front of it. Those affected with the disease are small, and as it progresses they grow smaller.[1]

The bistrochanteric diameter is lessened; the external conjugate is not lessened in all cases, but the promontory is always accessible, the narrowed pubic arch and the approximated horizontal pubic rami giving a beaked form to the anterior portion of the pelvis; and finally the diminished outlet will be more or less readily recognized. Further, half or the entire hand may be introduced into the pelvis, when the fact and the extent of the deformity can be better appreciated; during such examination possibly there may be ascertained that the bones are quite flexible; and this fact would make the prognosis as to delivery more favorable.

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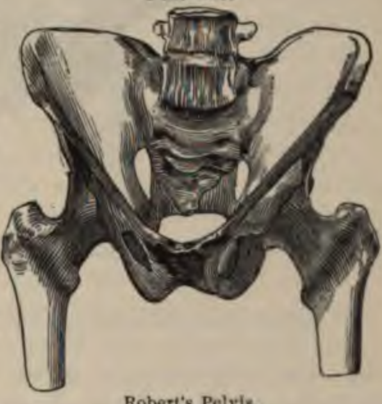
[1] In regard to the effect of osteomalacia upon the stature, two of the most remarkable stories are told by French authorities. Thus, in the year 1700, Lambert published the case of the marquise Bernard of Armagnac, who died when twenty-two years old, the stature having been lessened at least one foot, and in whom all the bones, except the teeth, were softened. But, according to the report of a monk, Abbon, there was in Paris during the Norman siege in 886 a man who was very tall, but who before dying became smaller than an infant.—*Dictionnaire encyclopédique des Sciences médicales*, article "Osteomalacie," by Albert Hénocique.

A general rule in regard to the conduct of labor in a case of osteomalacic pelvis is not to interfere too early, for the bones may prove so yielding under uterine contractions that the passage for the fœtus is opened, and thus a threatened Cæsarean section or embryotomy be averted.

(*b*) *The Ankylotic Transversely-contracted Pelvis.*—The first pelvis of this kind was described by Robert in 1842. Its origin seems to be in an arrested or imperfect development of the sacrum, followed by ankylosis of the sacro-iliac joints. The alæ of the sacrum are absent or only imperfectly developed; the sacrum is narrow, and has descended deeply between the ilia; the ischial tuberosities and spines approach. The antero-posterior diameters of the pelvis are normal or increased, while the transverse are much lessened; especially is the transverse of the outlet reduced. According to Kleinwächter, in the cases hitherto observed the transverse of the inlet varied from 7 to 10 centimeters (2.7 to 3.9 inches), and that of the outlet from 2.25 to 6 centimeters (0.8 to 2.7 inches).

Fig. 285.



Robert's Pelvis.

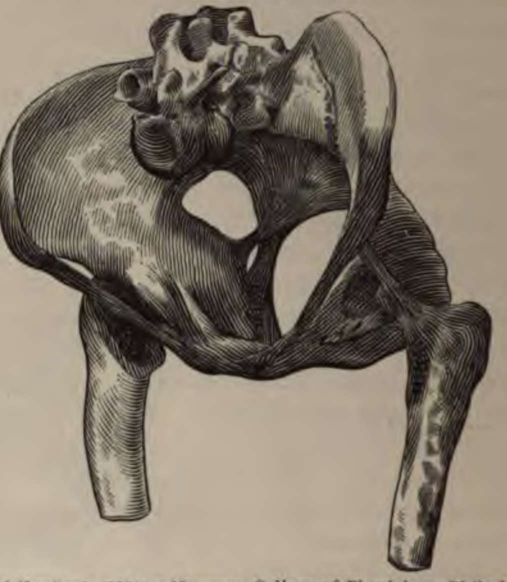
The symmetrical character of the deformity, each side of the pelvis being equally involved, leads to the rejection of its origin in any case in disease of the sacro-iliac joints, but this exclusive source is made in a congenital absence of ossification-centres in the sacral alæ; nevertheless, traces of inflammation of these joints have been found in some instances of this deformity.

The diagnosis is made by the narrowed pubic arch, the parallelism of the horizontal pubic rami without any abrupt bending of these bones which is observed in the osteomalacic pelvis, and chiefly by the great narrowing of the sacrum. This is a very rare anomaly, only nine cases having been observed. In six of the nine the Cæsarean operation was done. In two cases in which the transverse diameter of the inlet was 8 centimeters (3.1 inches), and that of the outlet 5.25 centimeters (2 inches), delivery was effected by cephalotripsy, and this is, therefore, regarded as the limit of its applicability.

(*c*) *The Kyphotic Transversely-contracted Pelvis.*—Kyphosis (κυφωσις, applied by Hippocrates to a bowing or curving of the spine, so that one was humpbacked) means an abnormal convex curvature of the spine.

The origin of the kyphotic pelvis is found in an abnormal posterior spinal curvature, for a compensating curvature lower down results from the former; and in order that the pelvis may be affected by the spinal anomaly, the latter must be situated in the lumbar vertebræ, or in these the sacral vertebræ must be affected, the one known as lumbo-dorsal, the other as lumbo-sacral, kyphosis. Further, the sacrum is pushed downward and backward: just as in a pelvic deformity previously considered this bone is pressed downward and forward, lessening the conjugate, a rotation of the bone upon its transverse axis forward, so that the sacral promontory is brought nearer the pubic joint, so now a corresponding rotation backward is claimed to occur. Some of these points may admit of dispute, as will be seen when we refer to the recent investigations of Barbour.

FIG. 286.



Lumbo-sacral Kyphosis (Mütter Museum, College of Physicians, Philadelphia).

From this author we quote the following summary of the peculiarities of the kyphotic pelvis based upon his examination: "The iliac crests are drawn out from before backward; the arching of the crests is diminished and their sigmoid curve lessened. The anterior superior spines are thrown apart. The pelvis is funnel-shaped. The conjugate diameter is greatly increased, while the transverse is relatively, and sometimes absolutely, lessened. The linea terminalis is less arched at the sides. In the cavity the conjugate is increased, but to a less extent than at the brim. Sacrum narrowed transversely and elongated vertically; its vertical curvature is diminished throughout its transverse in the upper portion of the bone. At the outlet the conjugate is not usually altered. The transverse may be contracted, and that to an extreme degree. The pubic arch is narrowed."

The most characteristic anatomical peculiarity of the kyphotic pelvis is an increase in the antero-posterior diameter of the brim. The contraction in the transverse diameter of the outlet, which is the feature of obstetric importance, is not so constant.

Further, Barbour, in opposition to the teaching of Breisky, states as the result of the study of the preparations he has had that there is not, as a rule, a rotation of the sacrum upon a transverse axis, and that the contraction at the outlet is not related to the elongation at the brim. He further maintains that the contraction at the outlet implies a rotation of the innominate bones; and this is shown by the fact that the approximation of the tuberosities is related to separation of the crests.

The most characteristic indication of the kyphotic pelvis is found in the presence of a lumbar kyphosis, and next in the peculiar walk of the subject, the movement being as if carrying some heavy load before her and a constant effort to avoid falling. By pelvimetry we find the true conjugate increased; the transverse measurements of the false pelvis are normal, but that between the posterior iliac spines lessened.

The distinction just given is the direct opposite of the conditions observed in the osteomalacic pelvis, with which this may be confounded, for in that the anterior transverse diameters of the false pelvis are lessened, while the distance between the posterior iliac spines is increased. The pubic arch is narrowed in the rachitic and also in the osteomalacic pelvis, while no narrowing is present in this. Besides, the first two occur in persons whose history points to one or the other disease. In such pelves, too, the promontory is quite accessible.

Of course the prognosis rests chiefly upon the degree of contraction. It is of especial importance in this connection to know the transverse diameter of the outlet, and this is best done by Chantreuil's method. (See p. 728.) Further, it is important to know if "the ischial tuberosities move upon being pressed apart. Korsch has demonstrated that even in the normal pelvis the transverse of the outlet can be thus slightly increased, this movement being accompanied by a diminution in the conjugate."[1] But before this observation both Mattei and Laborie have asserted that an increase in the transverse diameter of the outlet resulted from the wedge-like pressure of the fœtal head.

In consequence of the lessened abdominal capacity arising from a lumbar kyphosis, the uterus may be strongly anteverted, and hence difficulty in the head entering the inlet. But the most frequent fact as to the position of the child in the abdomen that has been observed is that the fœtal back is posterior—that is, toward the mother's spine—

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[1] Barbour: *op. cit.*

"probably in consequence of the pendulous abdomen generally present, the limitation of abdominal space, and the compensating lordosis of the upper portion of the spinal column, through which the anterior plane of the fœtus can be better adjusted to the anterior abdominal wall." This explains the frequency of occipito-posterior positions. According to Barbour, the shape of the pelvis favors posterior rotation of the occiput; that is, rotation into the pelvic cavity.

Barbour gives a table of 32 cases of kyphosis and 52 labors; there were 33 recoveries from these 52 labors, but of the 32 mothers, 19 ultimately died after labor. He thus finds in his collection of cases that there was a fœtal mortality of 52 per cent. and a maternal mortality of 36.5 per cent., according to the number of confinements, or 59.4 per cent., according to the number of cases of kyphosis.

The extreme limit admitted by Barbour for the application of forceps is 3.25 inches, and if this diameter is less he advises craniotomy. There were 7 cases of Cæsarean section, 6 mothers dying; 9 cases ended spontaneously, and 7 mothers recovered. Zweifel regards the prognosis as more favorable in that than in other pelvic contractions, because the narrowing is at the outlet. But he adds that Cæsarean section has been necessary, and as spontaneous rupture of the uterus has occurred, and even after the use of the forceps death rapidly followed, it is advisable in a given case to keep this possibility in mind.

*Rachitic Kyphosis.*[1]—While the changes in the pelvis caused by rickets are in the main directly opposed to those caused by kyphosis, on the other hand, should kyphosis result from rickets, the pelvis may present a similar form to that observed if the kyphosis has a different etiology. The kyphosis, in order to change the form of the pelvis, must, as in the account of the kyphotic pelvis just given, concern the lumbar vertebræ. The diameters of the outlet are lessened, and the diminution is greatest in the antero-posterior.

*The Third Class includes Pelves chiefly contracted in the Oblique Diameter.*

(*a*) *The Ankylotic Obliquely-contracted Pelvis.*—Dionis was credited by Naegele with having first alluded to the pelvis contracted in an oblique diameter. Certainly, this distinguished French accoucheur does refer to difficult labor caused by spinal deformities, and also to changes in the pelvis caused by rachitis, but his reference to the pelvis now to be considered is by no means clear.

The oblique-oval, or Naegele's basin, was first described by Naegele in 1839. It is distinguished by the fact that one sacro-iliac synchondrosis has been ossified, and as a consequence one-half of the basin becomes narrower.

The part of the sacrum belonging to the ankylosed side is imperfectly developed, and its union with the innominate bone is made by a narrow ledge of greatly condensed osseous tissue instead of by a broad articulating surface. There is slight scoliosis involving the lumbar vertebræ. In Kleinwächter's case there was also rachitis. The iliac bone of the affected side is raised and projects farther back than its fellow. The sciatic notch is lessened in consequence of the ischium being pressed upward and inward, and the ischial tuberosity and spine approach the sacrum.

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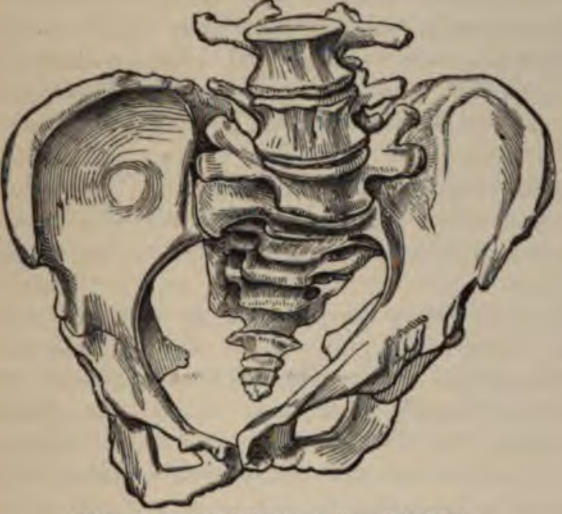
[1] *Zweifel.*

Fig. 287.



Obliquely-distorted Pelvis, or Naegele's Pelvis.

The absence or rudimentary condition of the sacral wing upon the affected side finds its most rational explanation in the absence of ossification nuclei, and therefore the deformity may have an intra-uterine origin: this was the view favored, though not exclusively adopted, by Naegele. But it is also held that the deformity may result from pathological conditions of the joint in infancy or childhood; in other words, inflammation lies at the beginning of the change. The theory of an inflammatory origin in some cases after birth does not exclude that possibly this inflammation may begin in intra-uterine life; if the inflammation occurs after being born, its cause may be simply pressure of the trunk, which will be greater upon that side corresponding with an imperfectly developed sacrum. It is impossible for disease of one of the sacral joints in adult life to cause the deformity.

Thomas[1] in 1861, from a study of the 50 cases of oblique oval basin up to that time described, classified them as to their etiology as follows:

(*a*) Oblique pelves found in women who during their infancy, or in all cases before the ankylosis was recognized, had suffered from disease of the pelvic bones, 9 cases.

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[1] *Das Schrägverengte Becken*, quoted by Naegele and Grenser.

(*b*) Oblique basins with fracture of the pubis on the same side as the ankylosis, 2 cases.

(*c*) Oblique basins with traces of periostitis or exostoses of the hip-bones, 3 cases.

(*d*) Oblique basins in which there was found, besides the ankylosis, a coxal arthritis of the same side or of the opposite side, 5 cases.

(*e*) Oblique basins without any other trace of disease, of which, nevertheless, the history was too imperfectly known to permit the absolute statement that in the women to whom these pelves belonged there was nothing observed, especially in youth, indicating a morbid state of the pelvic bones, 27 cases.

(*f*) Oblique basins without visible traces of disease of the pelvic bones in women whose history was sufficiently well known, so that it could be affirmed they had never suffered from any affection of the bones.

Whatever or whenever the origin of the deformity, the latter presents a most characteristic form which is well shown in the illustration that has been given. The pelvic inlet is asymmetrical, and presents the form of an obliquely placed oval with a point projecting to the ankylosed side. The antero-posterior diameter is increased, but the transverse is lessened, and there is a continued lessening of this diameter through the cavity and to the outlet.

Kleinwächter thus describes the changes in the basin conditioned by imperfect development of one-half of the sacrum: The sound side of the pelvis is developed, and grows normally both anteriorly and posteriorly. Its ilium is curved, because by the firm attachment of the sacro-iliac ligament to the posterior superior spine the growing wing of the sacrum exerts a strong pressure against the auricular surface. But, as on the other side a less pressure is exerted by the less developed half of the sacrum upon the innominate bone, the ilium remains flatter. Further, in consequence of the same imperfect development of this half of the sacrum, the corresponding sacro-iliac ligament is weak, less strong than that of the healthy side, and therefore the stronger one draws the pubic symphysis toward it, for this joint is always turned toward the sound side. As soon as the person with such a pelvis walks, the promontory and the two acetabula being subjected to increased pressure, the diseased half of the pelvis has to endure a greater pressure than the sound side, because the head of its thigh-bone is nearer the line of gravity. The ankylotic half of the sacrum is forced deeper in the pelvis, and the corresponding ilium moves upward and inward, the change beginning at the acetabulum. In consequence of the great pressure from the head of the femur the ilium is placed more vertically; the crista and linea innominata are higher, the ischial spines and tuberosities come nearer the sacrum. Finally, in consequence of the increased pressure, the osseous material in the vicinity of the ankylosis becomes more dense.

Most of the cases of obliquely-contracted pelvis have been diagnosed after death; the entire number of cases observed is given as about fifty, but probably this is too small. Zweifel states that with a great difference between the two sides of the pelvis the diagnosis during life cannot be difficult. Should there be delay during labor in the entrance of the head into the pelvis, the possibility of this deformity will be suggested if we find it impossible to reach the sacral promontory. The limping gait of the subject may not be observed, but it is important to learn whether there is any history of inflammation of the joint in infancy or childhood, and whether any evidences of suppuration following such inflammation can be found in healed sinuses. Freund claimed that, an examination being made per rectum, the woman standing alternately on one and then on the other foot, some movement would be detected in an unaffected joint, while the ankylosed one would be immobile.

Internal examination should be made with the half or with the whole hand, and thus the want of correspondence in the position of the ischial spines, the distortion of the promontory, and the displacement of the pubic joint will be learned. The most important external measurement in order to prove that the basin is asymmetrical is the distance between the trochanter major of one side to the iliac crest of the other, and *vice versâ*. Naegele directed the following measurements to be made:

1. From the posterior superior spine of one side to the anterior superior spine of the other side—from the right side behind to the left side in front—normally 21–22 centimeters.
2. From the trochanter major of one side to the posterior superior spine of the other—22.25 centimeters.
3. From the middle of the inferior margin of the pubic joint to the posterior superior spine of each side—17.25 centimeters.
4. From the ischial tuberosity of one side to the posterior superior spine of the other—17.5 centimeters.
5. From the spinous process of the last lumbar vertebra to the anterior superior spine of each side—18 centimeters.

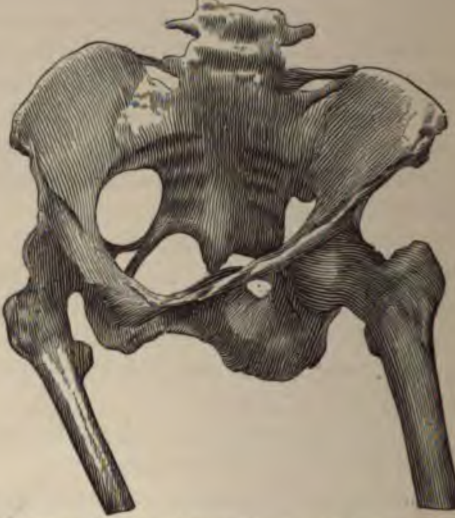
These oblique diameters, as Naegele termed them, must show a difference between each two corresponding ones of more than one centimeter in order to make the diagnosis of obliquely-contracted pelvis.

In this pelvis, if the ankylotic contraction be great, the passage of the child is necessarily made through that portion of pelvic space corresponding to the healthy side, for that which belongs to the ankylotic side is so contracted that no part of the fœtus can be admitted. The space, then, that is available is quite similar in form to that given by the justo-minor pelvis; and if labor be possible the mechanism is the same, the occiput descending first, as has been described in the course of labor occurring in that pelvis. Presentation of the breech is very unfavorable, because of the great difficulty in, or impossibility of, the passage of the head.

The prognosis as to the mother of course depends upon the degree of the deformity, the vigor of labor-forces, the size and degree of resistance to moulding of the fœtal head, and the size of the child: the maternal mortality given by Litzmann and Thomas is 80 per cent. But this high percentage is to be attributed to the fact that in most of the cases the deformity was not recognized soon enough for the use of appropriate therapeutic means, and in some instances, according to Kleinwächter, the means employed directly caused the death of the mother. Zweifel, too, regards Litzmann's statistics as being too unfavorable. He advises the forceps if the head enters the pelvis, but if this entrance be impossible the Cæsarean operation, especially as in cases of such difficulty uterine rupture is liable to occur.

(*b*) *The Coxalgic Obliquely-contracted Pelvis.*—This pelvis is similar to that just described, but there is this remarkable difference in manifestation. Thus while in the Naegele pelvis the arrest of development or the inflammation of the sacro-iliac joint affects the side of the basin in which it occurs, in this deformity the coxitis and subsequent ankylosis are upon the side of the pelvis which remains comparatively nor-

FIG. 288.



A Coxalgic Obliquely-contracted Pelvis (Mütter Museum, College of Physicians, Philadelphia).

mal, and the healthy side becomes misshapen. The pelvis above represented was taken from a negress upon whom Dr. R. G. Curtin performed Cæsarean section, and it exhibits very clearly the fact of the pelvic deformity being manifest upon the healthy side, while that upon which the coxitis occurred is normal. The history of the usual development of this pelvis is that a child suffers from coxitis so severely that the corresponding lower limb—for example, let the affection be upon the right side—becomes useless, and the weight of the body rests upon the left femur. This pressure causes similar changes in form in the basin to those observed in the Naegele. The left acetabulum is pressed upward, and it comes more in front; the innominate line is bent in front at an acute angle, and the left ilium is higher and less inclined; the left half of the sacrum is narrowed, so that the entire bone loses its symmetrical form; the left ischial tuberosity and spine move backward and outward, and the pubic joint is placed opposite the right side.

There are several modifications of the coxalgic oblique basin according to the period in adolescence when the disease of the joint began and as to the degree of use permitted by the diseased limb. Thus, the earlier in childhood the disease occurs and the more the limb is used, the greater the deformity. On the other hand, if the coxitis is first manifested after complete development of the basin, the obliquity may be completely absent.

So, too, the obliquity may involve first one side, and then it may change to the other. Zweifel gives the following illustration: A child has coxitis of the right side, ending in firm ankylosis, the right lower limb being shortened. It necessarily limps, and the concussion in walking will be greater than on the left side, this jar being felt not only at the hip-joint, but also in the corresponding sacro-iliac synchondrosis; hence, ascension of the iliac bone. If now a chronic inflammation in the sacro-iliac joint is superadded, the corresponding sacral wing will be retarded in its growth; hence the right half of the pelvis becomes smaller than the left half, the pubic symphysis is pushed to the left, and the oblique diameter of the pelvis from the left anteriorly to the right is shortened. Suddenly, however, all this may be changed, so that by muscular traction a pelvis presenting an opposite contraction may be developed. For if the child ceases to use the right lower limb, the plane of support is exclusively given by the left femur. But it is not necessary to follow the changes that then result in the form of the pelvis, the diseased side furnishing comparatively a normal condition of the corresponding side of the pelvis, and the healthy side becomes in this regard abnormal.

Paralysis of a lower limb or amputation of a leg is rarely followed by any great change in the form of the basin, because in the great majority of cases this has attained complete development before either occurs.

The coxalgic pelvis so gravely deformed as seriously to interfere with labor is rarely seen. The recognition of the deformity will be made, first, by having a history of coxitis in early life, and finding its effect in a useless abdominal member, and then by direct examination of the pelvis. In slight cases of the deformity labor needs no assistance, while in the grave ones labor and its treatment are the same as advised in similar circumstances in the Naegele pelvis.

(*c*) *The Scoliotic Obliquely-contracted Pelvis.*—This deformity arises from a scoliosis involving the lumbar vertebræ, there being thus caused a greater pressure upon that half of the upper articulating surface of the sacrum corresponding with the side toward which the spinal curvature occurs. By the connection of the sacrum with the innominate bone this increased pressure is transmitted to the femur of that side. But the resistance of the latter causes leaning inward of the parts adjacent to the acetabulum, and hence that side of the pelvis becomes greatly lessened. A scoliosis of the vertebræ toward the right diminishes and deforms the right half of the pelvis, while the left is similarly affected by a scoliosis with its curve directed to the left.

Should the scoliosis be limited to the dorsal vertebræ, a compensating curve of the lumbar vertebræ may prevent any influence upon the pelvic form.

This deformity renders one side of the pelvic canal useless, so far as furnishing space for the transmission of the child. The mechanism of labor is that described as occurring in the justo-minor pelvis, and the assistance to be given by the obstetrician, provided the contraction be not so great as to forbid the passage of a living child, is by forceps, remembering, however, that this instrument is not to be used until the head has been sufficiently moulded.

DEFORMITIES OF THE PELVIS CAUSED BY FRACTURES OR BY NEOPLASMS OF THE PELVIC BONES.—Fracture of the horizontal ramus of one of the pubic bones may result in serious deformity of the pelvis, because of the impossibility of keeping the broken ends of the bone in apposition during healing. Eugène de Saint-Moulin[1] narrates the case of a girl sixteen years of age who while working in a coal-mine was injured by the falling of a large mass of coal upon the lower portion of her back: after several months she recovered so that she could walk, though with some difficulty, and there was slight spinal deformity. Five years afterward she became pregnant, and the diameter of the superior strait being only three centimeters six millimeters, the Cæsarean operation was successfully done at the end of the pregnancy. Seven years after she was again pregnant, and at seven months rupture of the uterus occurred, the tear being in part of the uterine incision made in the previous operation, and the rupture ended fatally. The autopsy showed that, in addition to marked lumbar lordosis, the second sacral vertebra was crushed, so that the first was directly buried in the pelvic cavity, and there was a synostosis between its inferior border and the superior border of the third sacral vertebra. The spondylolisthesis had thus a very rare origin in this case.

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[1] *Journal d'Accouchements*, 1885.

Various neoplasms—enchondroma, sarcoma, carcinoma, exostoses, fibroma—may, originating from any part of the internal surface of the pelvic bones, encroach so greatly upon the bony birth-canal that the Cæsarean section is necessary.

Deventer, who was the first obstetrician to give any clear exposition of pelvic deformities, regarded the position of the coccyx in certain cases as furnishing a serious obstacle to labor, and devoted several pages of his well-known work to the consideration of this topic, giving explicit directions as to the method of pushing the bone back and thus enlarging the pelvic outlet. Some other obstetricians since have also regarded sacro-coccygeal ankylosis as an obstacle to be obviated by the obstetrician. But probably the truth is that in case of this ankylosis the pressure of the child's head is quite sufficient to overcome the resistance, breaking the synostosis, and there is no necessity for obstetric interference.

## ANOMALIES OF THE FŒTUS.

Fœtal anomalies causing dystocia may be conveniently classified as those of size, of presentation, of position, and of form in case of single pregnancy. But if the pregnancy be pluriparous, difficulties may occur when the twins, for example, are separate or when they are united, there resulting in the latter case what is termed a double monstrosity.

ANOMALIES OF SIZE.—It is proposed to consider under this head only those cases in which there is excess of development of the fœtus, the increase in size being physiological, reserving for another section those instances of perversion or of arrests of development, and pathological conditions, as, for example, œdema, emphysema, effusions in serous cavities, and neoplasms.

It is usual, in case the pregnancy be prolonged some days beyond the normal term, to find the fœtus of greater size than the average. Some women, too, though their labors are at the normal period, give birth to children whose great development presents a more or less serious obstacle to labor, and stillbirths are not infrequent. It sometimes happens that advanced ossification of the bones of the head prevents their ap-mal flexibility and mobility, and hence a favorable moulding of this part adapting it to the birth-canal: thus, spontaneous labor may be rendered impossible, and even craniotomy necessary.

Occasional instances of excessive, even of enormous, development of the fœtus have been reported from time to time. Thus, Kormann refers to a labor in which the child presenting by the breech was still-born and weighed 9.8 kilograms.

It is impossible in most cases to make the diagnosis of excessive size of the fœtus with absolute certainty during pregnancy; but during labor and after the rupture of the membranes we can, supposing that the presentation is cranial, ascertain by the slow descent of the presenting part notwithstanding vigorous uterine contractions, by the lessened convexity of the bones that can be felt and by their greater resistance, and by abnormal increase in the distance between the anterior and posterior fontanelles, that the head is of unusual size.

Essentially, the labor presents the same characteristic as that of labor in a generally contracted pelvis; there is the same loss of harmony of relation between the passenger and the passage in one as in the other. So, too, the same general plan of treatment is applicable during most of the labor. Thus, in case the delivery of a living child is possible, the obstetrician waits until the head has been by Nature's efforts given suitable form for transmission, and then, if necessary, applies the forceps.

It not unfrequently happens, however, that in these cases, after either the spontaneous or artificial delivery of the head, the shoulders will not pass through the outlet or through the vulvar orifice, and the life of the child is in instant peril: the difficulty in delivery is increased if the child has respired, for of course the size of the thorax has been thus made greater. In this emergency the obstetrician endeavors first to deliver by direct traction upon the head, made either by applying the hands to each side of it or two fingers of one hand under the chin and two of the other hand beneath the occiput. If this method fails, then let the head, supposing external rotation to have occurred, be carried backward toward the perineum, some traction being made; this step is taken in order to bring the pubic shoulder into the arch and cause it slightly to emerge, thus endeavoring to imitate the normal mechanism of shoulder delivery, for in that the partially-delivered anterior shoulder pivots upon the subpubic ligament, remaining fixed until the posterior shoulder is completely expelled; after the upper shoulder has become thus fixed the head is carried upward, when possibly the posterior will be born. Failure still occurring, we may push the anterior shoulder upward behind the pubic joint, and then by traction attempt to deliver the posterior shoulder. It should be remembered that in these and other efforts to deliver the thorax there must be as

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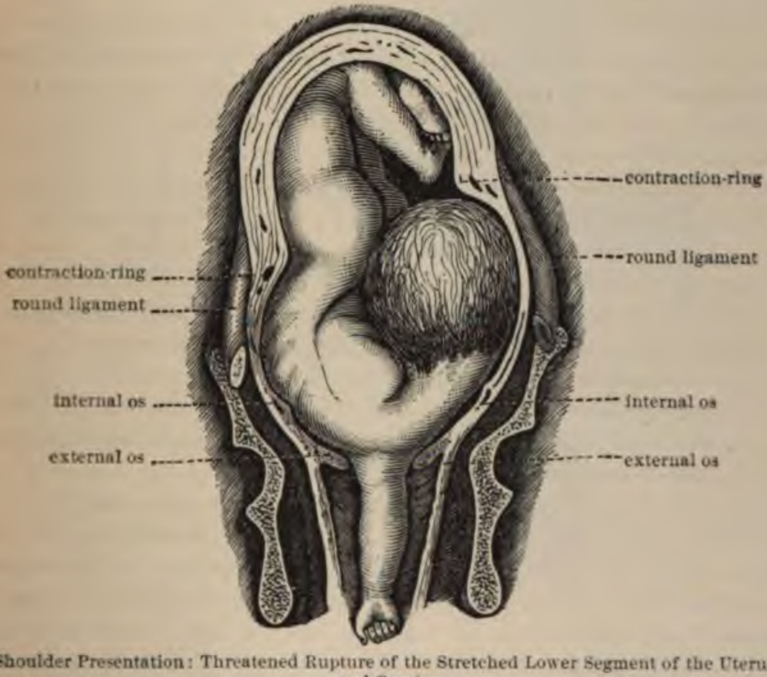
Whether we use the term spontaneous evolution or expulsion, or call it, with German obstetricians, Selbstentwicklung, according to Zweifel the process is so rare that only 10 cases were observed by Reike in two hundred and twenty thousand labors; Busch in 6180 only 2; Späth 5 in 15,523; Kuhn 9 in 17,375; and Arneth none in 6608: hence the obstetrician cannot trust to this method of delivery. The complication without the intervention of art at the proper time is a very grave one for both mother and child; the latter, from the long continuance of the labor and from the firm contraction of the uterus interfering with the placental circulation, or from direct pressure upon the cord, perishes with asphyxia, while the former is liable to rupture of the uterus, followed by dangerous hemorrhage or by septicæmia. The liability to rupture of the uterus arises from the continuance of uterine activity struggling against an invincible obstacle, with consequent thinning of the lower uterine segment, in some part of which the tear occurs. The accompanying illustration, from Schroeder, shows better than words can describe the condition of the uterus in neglected shoulder presentation and when rupture is imminent.

Fig. 289.



Shoulder Presentation: Threatened Rupture of the Stretched Lower Segment of the Uterus and Cervix.

ture of the membranes descent of the arm not unusually follows, or, if there be doubt as to the presentation, this may be drawn down, when not only confounding it with a foot is impossible, but by examining the position of the hand we can know whether the back is anterior or posterior, for the dorsum of the hand is superior if the back is in front, but the palmar surface occupies such position if the back of the child is posterior. Further, by observing with which of the obstetrician's hands the palmar surface of the child's hand corresponds he knows whether the right or the left shoulder presents. It should be remembered, however, that the descent of a hand does not necessarily prove a shoulder presentation, for in some instances this member comes down in front of the head, or even of the pelvis, thus making a compound presentation; and therefore to avoid possible error the hand should be followed up until the part actually presenting is reached.

Spontaneous delivery is possible in one of three ways:

1. As Roederer first observed, the child being small and readily compressible, a lateral doubling of the body, *corpore conduplicato*, may occur, and the child, thus folded upon itself, is so compressed that it may be forced through the birth-canal.

2. Spontaneous version may occur. In presentation of the shoulder the uterus has taken an abnormal form, but if restitution of form occurs—that is, if the uterus takes its normal ovoidal shape—the fœtal ovoid is compelled to assume a corresponding position, and thus one or other of its poles, the cephalic usually, takes its place in the lower portion of the uterine cavity. This seems a more rational explanation than that which attributes the change of presentation to any irregular action of parts of the uterine muscular walls; there is simply a delayed but complete return of the uterus to its normal form, and the great law of accommodation, which plays so important a part in obstetric phenomena, is here manifested in the substitution of a normal for an abnormal presentation.

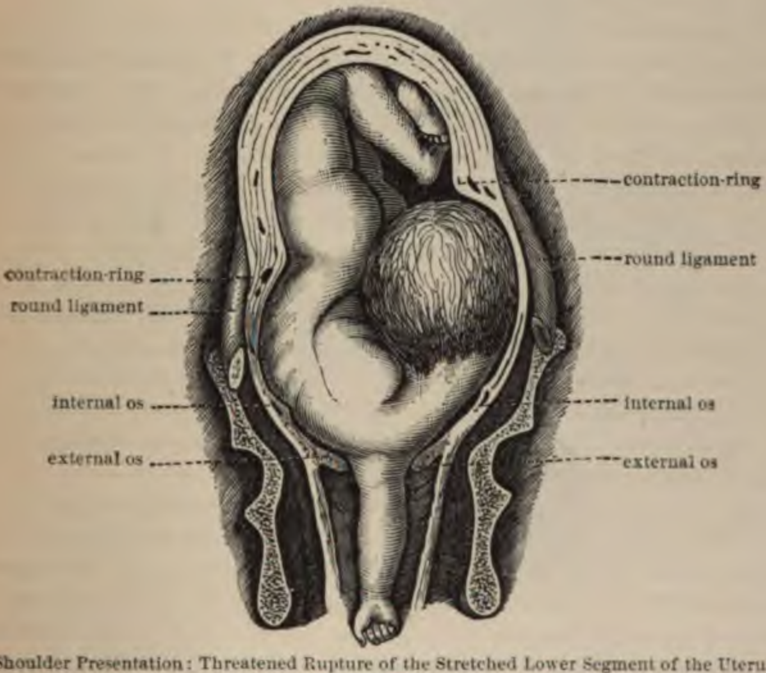
3. What is now designated spontaneous evolution may occur. This process was first described in 1811 by Dr. Douglas, a distinguished practitioner of Dublin, and called by him spontaneous expulsion, a more appropriate name than that which is now employed.

In the first variety of spontaneous delivery the head and body are delivered together, but in this the body is first expelled and afterward the head. The presenting shoulder passes so far down and out that it presses upon the pubic joint anteriorly, and is there fixed, while the body of the child, strongly compressed and flexed, is forced downward and out, the pelvis delivered last, the head meantime remaining in the pelvis; after the body has been expelled the head is delivered by the same mechanism as that occurring in an original pelvic presentation.

It must be obvious that both the first and second classes which have been given might be included under the general head of self-expulsion, but also that they differ in the process.

Whether we use the term spontaneous evolution or expulsion, or call it, with German obstetricians, Selbstentwicklung, according to Zweifel the process is so rare that only 10 cases were observed by Reike in two hundred and twenty thousand labors; Busch in 6180 only 2; Späth 5 in 15,523; Kuhn 9 in 17,375; and Arneth none in 6608: hence the obstetrician cannot trust to this method of delivery. The complication without the intervention of art at the proper time is a very grave one for both mother and child; the latter, from the long continuance of the labor and from the firm contraction of the uterus interfering with the placental circulation, or from direct pressure upon the cord, perishes with asphyxia, while the former is liable to rupture of the uterus, followed by dangerous hemorrhage or by septicæmia. The liability to rupture of the uterus arises from the continuance of uterine activity struggling against an invincible obstacle, with consequent thinning of the lower uterine segment, in some part of which the tear occurs. The accompanying illustration, from Schroeder, shows better than words can describe the condition of the uterus in neglected shoulder presentation and when rupture is imminent.

Fig. 289.



Shoulder Presentation: Threatened Rupture of the Stretched Lower Segment of the Uterus and Cervix.

The general indication in case of a shoulder presentation, so far as treatment is concerned, is to perform version, podalic rather than cephalic being usually selected, though really the latter can in many instances be successfully done and with comparative facility, especially by the method proposed and practised by the late Dr. M. B. Wright. But in some cases the very act of version may be the cause of the injury, or in others the tear has already occurred and the obstetrician receives the blame, and in still others version is impossible. As long as the membranes are unruptured there is no danger of uterine rupture, and therefore the obstetrician need not be in haste to intervene, but wait until full dilatation occurs, thus facilitating the operation. But after the escape of the waters delay is dangerous, for, as the labor-activity continues, the uterus closes round the child, the shoulder is driven deeply into the pelvis, the lower uterine segment is more and more thinned, the contraction-ring is felt farther up in the abdominal cavity—upon one side it is higher than upon the other—the round ligaments are tense, and rupture is at hand. The responsibility for the accident, as Zweifel states, then rests upon the obstetrician who has failed to perform version at the proper time.

Still another abnormal condition may occur in a shoulder presentation—a continued uterine contraction or tetanus of the uterus. Winter attributes this to the untimely administration of ergot or to mechanical irritation from mechanical causes; that is, from fruitless attempts at version. But, as Zweifel justly remarks, there may be tonic contractions of the uterus, as well as tetanus, without the administration of ergot or without any attempt at delivery, solely in consequence of premature rupture of the membranes.

The rule of practice, then, is to turn as soon after the rupture of the membranes as practicable, for if we wait until complete dilatation of the os occurs the dreaded accident may anticipate this condition. If uterine tetanus has come, we may try to abate it by chloroform and by the hypodermic use of morphia, but the child most probably is dead; the mother's life is in great and immediate peril, and its salvation may depend solely upon a prompt embryotomy.

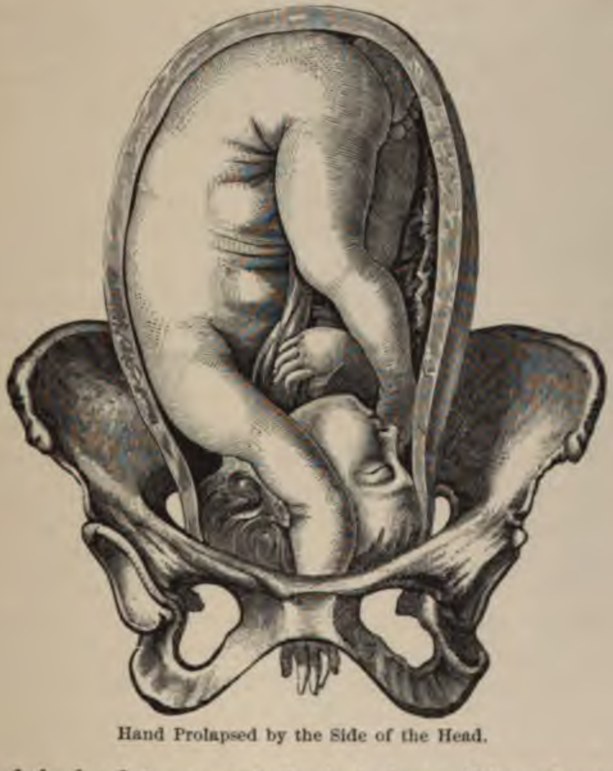
In some cases, even after the waters have been discharged for a long time, turning may still be possible, but the condition of the uterus ought to be carefully examined before we attempt this operation, lest we may cause by it the very result which we are seeking to avoid.

COMPOUND PRESENTATIONS.—By these are meant the descent with the presenting part of one or more unrelated parts. The descent of the arm in a case of shoulder presentation presents no complication, for these are related parts. But if such descent occurs with the head, the presentation is no longer simple, but compound. La Motte has related a case of labor in which the head, the hands, and one of the feet presented.

Madame Lachapelle[1] and all authors who have written upon the subject since have admitted as predisposing or occasional causes the small size of the fœtus, the abundance of the amniotic liquor, its rapid discharge, oblique presentation of the fœtus—when, for example, instead of being directed in the middle of the inlet, it is turned obliquely toward one side—and, finally, vices of conformation of the pelvis. Charpentier adds to these causes rupture of the membranes while the woman is standing, and unskilful or untimely efforts to perform version.

If the hand descends with the head—and this is the most frequent variety of the accident with which the practitioner will meet—the advance of the head is arrested, for it is impossible, unless the child is unusually small or the pelvis abnormally large, for the two to pass together through the birth-canal.

FIG. 290.



Hand Prolapsed by the Side of the Head.

The DIAGNOSIS after the rupture of the membranes presents no difficulty, and therefore need not be given. Should the diagnosis be made before this occurs—the obstetrician feeling a mobile, floating body presenting with the head, it is a matter of indifference whether hand or foot, so that discriminating between the two, often then difficult or impossible, is unnecessary—it is important that the woman lie down, and preferably on the side opposite to that upon which the member has been felt; especially is it important that she should be recumbent when the membranes rupture and the gush of liquor amnii occurs. In case the hand presents with the head after the amniotic fluid has passed off, the first endeavor should be to push it up, so that the head can descend alone. If this fails, podalic version is indicated. If a case should present the unusual complications which occurred in La Motte's, the method pursued by this wise obstetrician is to be followed; that is, push up the head, bring down the second foot, and extract the child by traction upon both feet.

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[1] Depaul.

ANOMALIES OF POSITION.—By these are meant those cases in which anterior rotation of the chin in presentation of the face, or of the occiput in that of the vertex, does not occur. There is, however, this important difference as to the necessity of anterior rotation of the chin in one, of the occiput in the other presentation: in the former such turning in front is absolutely needed in order that delivery can occur, but in the latter delivery is possible without the change referred to: it will be very tedious, it is peculiarly liable to be attended with injury to the perineum, and the delay in birth may cause the sacrifice of the life of the child; but still spontaneous or artificial delivery, without any mutilation of the fœtus, can occur, the occipital end of the head lever escaping over the anterior margin of the perineum.

In delayed anterior rotation of the chin with posterior of the forehead we may endeavor, by pushing upon one side of the forehead or by drawing with the finger upon the malar apophysis, to bring the chin forward. Penrose advises pressing with a single blade of the forceps or with the hand upon the posterior cheek. If pressure be made directly upon the forehead, not upon one of its sides, we thereby increase the extension and retard the descent of the part then foremost, and in so much facilitate that of the chin, and at the same time contribute to anterior rotation of the latter, for a mobile body subjected to a sufficient driving force and to two unequal resisting forces rotates in the direction offering the least resistance.

Various methods of effecting, or at least endeavoring to effect, anterior rotation of the occiput when this is turned toward one of the sacro-iliac joints have been proposed and tried: they are so well known that it is unnecessary to mention them here, only stating that they include the use of the entire hand or of one or two fingers, the employment of bimanual rotation acting upon each end of the fœtal ovoid, the method of Mattei, and rotating by means of the forceps. The principle previously mentioned as to effecting anterior rotation of the chin has its application here. But it is the desire of the writer to call especial attention to the value of Tarnier's forceps—not used for rotating, but simply to pull with—for when properly employed rotation of the occiput anteriorly is almost certain.

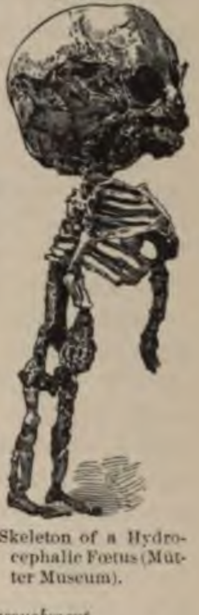
## ANOMALIES OF FORM.

Under this head it is proposed to consider pathological conditions of the fœtus causing dystocia, as well as different malformations or arrests of development, whether of a minor character or so grave as to make the fœtus monstrous, that have a like result.

### ANOMALIES CAUSED BY DISEASE OF THE FŒTUS AND ARREST OF DEVELOPMENT.—SINGLE MONSTERS.

Hydrocephalus, abnormal collection of serous liquid in the cranial cavity, first[1] fully described by Smellie in 1765, is not a frequent affection. Merriman's statistics gave 1 in 900; Lachapelle's, 15 in 43,545, or nearly 1 in 3000. Polyhydramnios frequently, but hydrorachis rarely, accompanies hydrocephalus. The great development of the head interferes with the normal accommodation of the fœtus, and hence there is a much larger proportion of pelvic presentations than when the fœtus is normally developed; Poullet[2] in 136 cases found 30 in which the pelvis presented. So far as the life of the fœtus is concerned, it seems to be well established that in no case in which artificial delivery was necessary did the child live, and therefore there should be no hesitation in lessening the size of the head. The mother is peculiarly liable to rupture of the uterus, as the statistics of Keith show; in one of Depaul's patients violent straining during expulsive efforts caused pulmonary emphysema, which was fatal.

FIG. 291.



Skeleton of a Hydrocephalic Fœtus (Mütter Museum).

The circumference of the head is, according to Spiegelberg, not rarely increased to 65–80 centimeters.

The DIAGNOSIS of hydrocephalus, should the head present, is made by the large size of the presenting part, by the wide intervals offered by sutures and fontanelles, by the bones being less convex, less firm, and more flexible than in the normal head; during a uterine contraction the scalp, instead of being wrinkled, remains smooth and tense, and there is no overriding of the bones. Combining digital examination with abdominal palpation, it is in some cases possible after the rupture of the membranes to perceive distinct fluctuation between the finger and the hand. In pelvic presentation a diagnosis is rarely made until the body is delivered, and then the arrest of labor from the difficulty of the enlarged head entering the inlet leads to careful internal and external examination, by which the cause of delay is learned. By palpation of the abdomen the uterus is found much larger than it ought to be after the expulsion of the child, and a large body is contained in it. The internal examination may permit touching the occipital bone, which presents the peculiarities previously mentioned as belonging to the bones of the hydrocephalic head; carrying the hand by the enlarged head for the purpose of disengaging an ascended arm, the distance is found very great, or the hand simply used for examination will learn some of the characteristic conditions of hydrocephalus.

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[1] See Hergott: *Des Maladies fœtales que peuvent faire obstacle à l'accouchment.*

[2] *De l'hydrocephalie fœtale dans ses rapports avec la grossesse et l'accouchement.* Peu (*op. cit.*) stated that the head of the child may be so filled with water or wind that it is impossible to introduce the hand, or even to employ any instrument to draw upon it, without first opening the head. Dionis (*op. cit.*) recognized the affection as hydrocephalus, and taught the necessity, in certain cases where the delivery was impossible, of puncturing the head.

The diagnosis is in some cases, however, quite difficult. Spiegelberg,[1] referring to the subject, made the following observations: "The widely gaping sutures and fontanelles are generally the most certain and easily recognized signs. But this condition is not always present. Complete cases of hydrocephalus occur in which the distended structures in the sutures are greatly ossified, and thus present no variation from the normal skull, and there are others in which the bones are not thin like paper, but are strong and thick, and fluctuation fails. On the other hand, skulls are sometimes seen having the usual size, but there has been delay in ossification, so that the sutures are wide. In doubtful cases the most reliable signs of hydrocephalus are the abnormal relation between the face and the brow (the latter being broad and prominent), the wide frontal suture, and the brow narrowing into the face. If, on account of the high position of the presenting part, we cannot accurately explore the head by touch, or if the child presents by the breech, we are confined to the evidence obtained by external palpation and the presence of a large and yielding head, which, of course, it is not always easy to make out."

In pelvic presentation the child probably has lived until its progress has been arrested at the inlet, and the obstetrician by pressure and traction vainly endeavors to make the head pass, and during these efforts witnesses the child's death.

The mortality to the mothers is, according to the statistics of Poullet and Spiegelberg, about 25 per cent. Nevertheless, the prognosis thus given is too unfavorable, for if there be no complications—such as placenta prævia, for example—if the hydrocephalus be recognized soon enough to prevent one of the most frequent accidents attending it, rupture of the uterus, proper means of course being taken to prevent such a result, recovery would probably be the rule, and very few exceptions occur.

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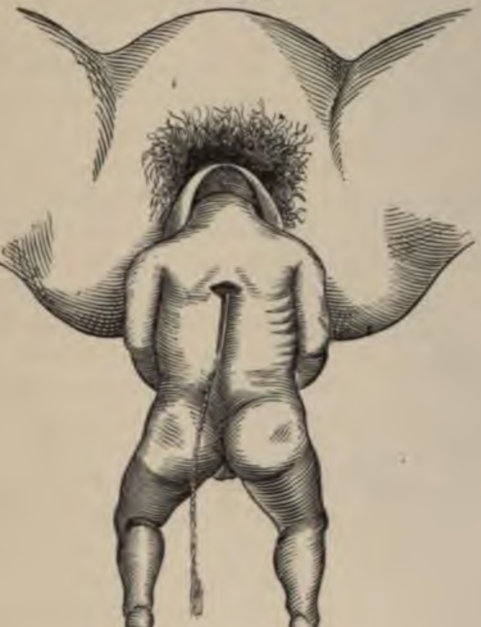
[1] *Op. cit.*

The TREATMENT immediately demanded in all cases in which labor is materially delayed by hydrocephalus is puncture of the head, and then, if the labor does not end spontaneously, delivery by traction from within or from without the head: the fingers, the crotchet, or a rod of wood two inches and a half long, to which a strong piece of cord is attached at the middle, slipped into the cranial opening, then placed transversely, may be used for traction, or forceps carefully used, or the cephalotribe. Some have advised turning the fœtus after puncture of the head, but this is unnecessary, and in some cases impossible because of the retraction of the womb around the fœtus.

In cases of pelvic presentation there is danger of dragging the body away from the head in the attempt to bring the latter through the pelvic inlet: that accident has happened more than once, and instances may be found in the pages of Mauriceau and La Motte. If, then, the fœtus cannot be delivered by moderate traction conjoined with suprapubic pressure, it is better to lessen the size of the head by puncture. Per-

FIG. 292.



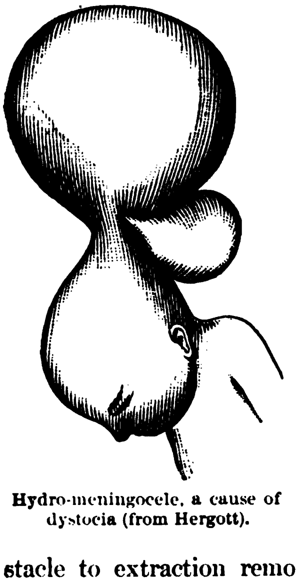
Evacuating the Skull, in a case of Hydrocephalus, through the spinal canal.

foration has been made through the palatine vault, at the occipital bone, behind the ear, or through a lateral fontanelle. The difficulty, almost insuperable in some cases, of reaching the head with a suitable instrument, led Van Huevel to suggest the following method of evacuating the dropsical fluid, and it has been successfully employed: The spinal canal is opened by a transverse incision about two inches long, as near the body of the mother as possible; then a rubber sound with a firm mandarin is easily passed through the opening and up to the cranium; withdrawing the mandarin, the fluid readily flows through the catheter. If there should be hydrorachis also, of course the operation of Van Huevel is simplified. The suggestion of the operation was attributed by the elder Hubert to Lacoux. It was first performed by Tarnier in 1876; Charles states that he has frequently done it.

While violent traction has, as has been stated, unintentionally caused separation of the trunk from the head, some obstetricians have by choice employed detruncation. In a case in which this was done by Dubois sufficient fluid escaped to permit the ready delivery of the head. In Verrier's case (1873) the operator, after separating the body from the head, ruptured the anterior fontanelle with the hook on one of the branches of the forceps.

ENCEPHALOCELE.—Hernia of the brain presents a round, soft tumor, the color of the skin covering it unchanged, caused by failure of ossification at the sutures and fontanelles. In hydrencephalocele there is a hernia of part of the brain, with a pouch containing serous fluid and communicating with one of the ventricles. According to Hergott, the first case of hydrencephalocele, also called hydro-meningocele, described was one by Ruysch in 1691. The adjoined illustration is of a case observed by Tarnier. Finding in the labor two heads, as he thought, he delivered by podalic version. Poole also delivered in a similar case by podalic version; the child was well developed, but had hare-lip and cleft palate upon the left side: it lived for two days. In the case reported by Deslandes the child presented by the pelvis, and, delay occurring in the delivery of the head through the inlet, the head was punctured and the obstacle to extraction removed.

FIG. 293.



Hydro-meningocele, a cause of dystocia (from Hergott).

The following illustration of podencephalus[1] is a variety of exencephalian monsters in which the hernia of the encephalon is made from an opening in the cranial vault normally existing, a fontanelle or suture, and not resulting from a failure of bony development, as in hyperencephalia; the hernia in this illustration occurred at the left fronto-parietal suture.

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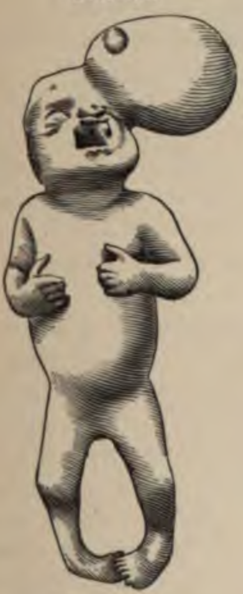
[1] The word is from πους, ποδος, foot, and ἐγκεφαλος, encephalon. The illustration is

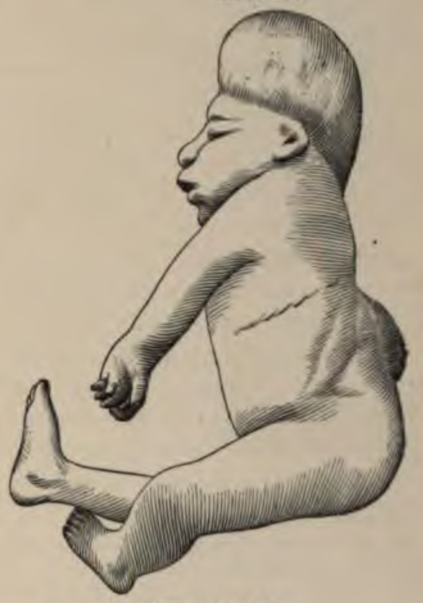
In *hyperencephalia*, according to Saint-Hilaire, the encephalon is situated in very great part outside of the cranial cavity and above the cranium, of which the superior part fails almost completely. "This is rarely the sole malformation presented by the fœtus; frequently there is a hare-lip, or ectromelia, etc. According to Geoffroy Saint-Hilaire, the fœtus is almost always of the male sex, born prematurely, and not viable." The presence of spina bifida and the distortion of the limbs will be observed in the illustration. The figure (taken also from a specimen in the Museum of the Philadelphia College of Physicians) represents a hyperencephalocele, the tumor appearing at the upper portion of the head. Charpentier regards presentation of the head as most favorable, but with the experience of Tarnier and Poole it would seem that delivery with the head last is best. But, whether head first or last, it may be necessary to diminish the tumor, as was done by Dr. Deslandes, in order that delivery can be possible. The illustration also shows the complication of the cranial tumor with

FIG. 294.



Podencephalia.

FIG. 295.



Hyperencephalus.

(Mütter Museum, College of Physicians, Philadelphia.)

from a specimen in the Museum of the Philadelphia College of Physicians. In some instances the polypoid form is much more distinct, the pedicle being small.

spina bifida, failure of ossification of the arches of the lumbar vertebræ being associated with similar deficiency on the part of some of the cranial bones.

Hernia through the base of the cranium is rarely met with. For example: in 93 cases of encephalic hernia collected by Houel there were only 9 of this variety. The seat of the hernial opening varies, but it is most frequently at the cribriform plate of the ethmoid bone, but it may occupy one of the sutures which unite the frontal and the nasal bones or to the superior maxillary. It is hardly possible that any of these herniæ can be so large as to interfere with labor, but they may, in case of cranial or facial presentation, render the diagnosis during labor difficult or impossible: the introduction of the entire hand into the pelvic cavity may be required to ascertain what part is presenting.

EXENCEPHALIA.—In this condition, the fœtus classified among monstrosities[1] by Geoffroy Saint-Hilaire, the upper portion of the cranial vault is almost entirely absent, and the greater part of the brain is external. Fig. 296 (Philadelphia College of Physicians' Museum) shows, associated with exencephalia, defective formation of the abdominal wall, to which reference will be made hereafter.

PSEUDENCEPHALIA.—In this there are only vestiges of nervous substance and the cranial vault is almost entirely absent.

In cases of exencephalocele difficulty in labor is rare, but that of diagnosis during labor may be great; and to remove this the introduction of the hand into the pelvis may be necessary. Should a fluid sac be associated with the exencephalia and by its size interfere with delivery, obviously puncture is indicated.

TUMORS OF THE NECK.—These may be fluid or semisolid, and in rare instances are so large as to cause dystocia. Monod[2] reported a case of difficult labor caused by a tumor of the neck as large as the fully-developed fœtal brain; it was pedunculated: the child was delivered living, and survived three days. Braxton Hicks[3] has recorded the case of a fœtus having a large cystic tumor of the neck, and puncture was

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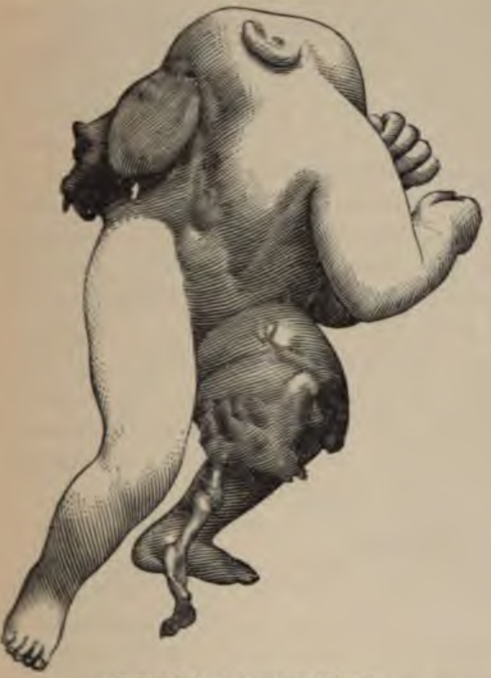
[1] It is difficult or impossible to give an acceptable definition of a single monster or monstrosity—a definition that will escape criticism. Littré has said that the word "monstrosity" is sometimes employed to signify any primary alteration whatever from the original specific type, from the simplest to the gravest—sometimes only the graver and more apparent anomalies, those which sensibly alter the form of organs and seem original, or at least are never due to an accidental cause. The word represents an ancient superstitious idea, and is derived from *monere*, to admonish, to warn, or to predict, and the birth of a monster was supposed to foretell evils or misfortunes: the monster was a divine omen. Festus defines *monster* as "quod moneat voluntatem deorum."

If we consider the first part of the definition given at the beginning of this note, a child born with hare-lip, a condition readily remedied by a surgical operation, as observed by another, would be called a monster, yet such an application does not correspond with the general meaning attached to the word.

[2] *Arch. Gen.*, 1829.

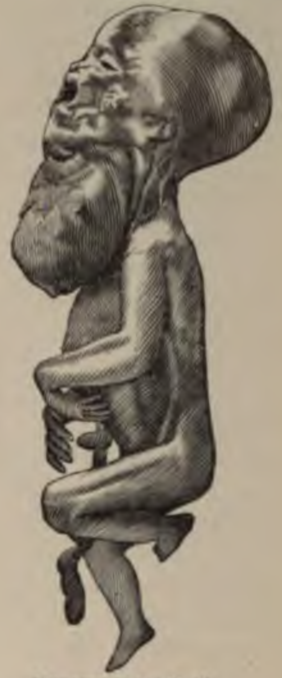
[3] *London Obstetrical Society's Transactions*, vol. v.

FIG. 296.



Exencephalia; also Omphalocele.

FIG. 297.



Myxoma of the Neck.

(Mütter Museum, College of Physicians, Philadelphia.)

necessary in order that birth could occur. Dr. Longaker of Philadelphia recently met with a case of difficult labor caused by a large myxoma of the neck: the above illustration shows the tumor and fœtus; of course the abnormal growth was much lessened in the delivery. I am also indebted to Dr. L. for the accompanying description: "The woman, who was seen by him in consultation with Dr. Santee, had a protracted first stage of labor. When the os was fully dilated the membranes were ruptured, and an excessive amount of amniotic fluid was discharged, so that the bed was saturated and a stream ran on the floor. The fœtus presented by the feet, and, the pains being inefficient, ergot was given. No difficulty occurred until the upper part of the trunk engaged. Very strong traction was unsuccessfully made, but the spinal column parted and the body was partially separated from the head. But this allowed some of the brain-like portion of the tumor to be discharged, thus diminishing its size and allowing it to engage with the head. After delivery the tumor was the size of an average fœtal head at term. Fœtus corresponded to the twenty-fifth to the twenty-sixth week."

Hayes[1] met with a difficult labor caused by a myxoma of the fœtus;

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[1] *Lond. Obstet. Soc. Trans.*, vol. xviii.

the tumor was near the shoulder, and extended from the sternum nearly to the vertebral column; it was necessary to puncture it before labor could end.

HYDROTHORAX.—No instance of hydrothorax by itself complicating labor has been recorded, but such complication has been observed in cases in which this affection was associated with similar accumulations in other serous cavities. Thus in a case reported by Galleti (1776) the obstetrician, having first separated the head from the trunk of a fœtus by traction with the forceps, could not deliver the body until the chest was punctured, and then the abdomen, a large amount of fluid being evacuated from each. In a case reported by v. Siebold there were dropsy of the chest, of the pericardium, and of the abdomen, and hydrocele: the delivery was very difficult, and effected by the forceps.

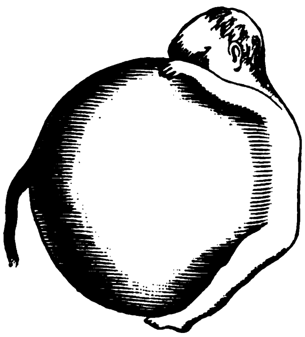
ASCITES AND ABDOMINAL TUMORS.—HYDRONEPHROSIS.—Ascites as a cause of difficult labor has been frequently observed. A case is reported by Robert in which, after having brought down the feet, the accoucheur found the labor arrested by ascitic swelling; the scrotum, too, was greatly distended, and upon its puncture not only the fluid it contained was evacuated, but also so much of that in the abdominal cavity that the child was readily born.

Hergott gives two instances in which an encysted tumor of the abdominal wall was an obstacle to delivery.

The bladder greatly distended with urine may, as in the subjoined illustration, be a cause of dystocia.

Fearn[1] has reported the case of a woman taken in labor when her pregnancy had lasted between seven and eight months, the head and umbilical cord presenting; after some time the head was delivered, and then the labor was arrested; the arms were removed, the chest opened, and then a large elastic tumor in the abdomen, pressing up the diaphragm, was discovered: the tumor was punctured, the puncture giving escape to a large amount of reddish, watery fluid, and the labor soon ended. Examination of this tumor showed that it was the bladder, but unconnected with the urethra.

FIG. 298.



Distension of the Bladder of the Fœtus.

Porak[2] has reported the case of a woman taken in labor at eight months, who after ineffectual attempts at delivery at home was brought to the Hospital Saint-Louis. The head and arms of the fœtus had been torn off in useless efforts to extract the child. Porak, recognizing that the dystocia was caused by distension of the fœtal abdomen, punctured it, and delivered. The cause of the distension was proved upon examination after delivery to be retention of urine, hydronephrosis, and cystic degeneration of the kidneys.

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[1] *London Lancet*, May 9, 1835.

[2] *La France Médicale.*

Madge[1] has given the history of a difficult labor, the breech presenting, and delivery of the body only effected by strong traction by means of a silk handkerchief passed over the buttocks and the thigh: the impediment was found to be a greatly distended condition of the child's abdomen, caused by the kidneys being so greatly enlarged that they resembled a bullock's kidneys in size, and also were like them in shape; each lobule "was converted into a serous sac, giving the appearance of, and constituting each kidney, a complete serous tumor." According to Hergott,[2] the first reported case of enlargement of the kidneys causing dystocia was that of Massna, regimental surgeon and practitioner of medicine, Copenhagen, 1828: the volume of the two kidneys was more than double that of the fœtal head.

Morris[3] states that congenital hydronephrosis may give rise to tedious and protracted labors, and even render delivery impossible until the abdomen of the child has been reduced by tapping. Braxton Hicks[4] has reported a case of labor made difficult by ascites associated with hydronephrosis. Ahlfeld[5] has given an example of dystocia caused by distension of the ureters.

In some instances of difficult labor caused by fluid enlargements in the abdomen, the child presenting by the feet, the difficulty has been removed by spontaneous rupture of the sac or organ.

Olshausen[6] has reported an example of great distension of the abdomen from an unusual cause impeding delivery: examination of the condition, after delivery, of the child, which was a female, showed that there was both urethral and anal atresia, and that the abdominal enlargement was caused by three tumors or pouches filled with liquid; the smallest was the bladder, and the next in size was the uterus, also filled with urine; and, finally, the third, larger than both the others, was the left colon. Comer Davies[7] has also given an instance of abdominal distension from an extraordinary cause: the child was a female, and its abdomen was chiefly occupied by a tumor which resulted from the impervious vagina being filled with fluid.

A third instance of abdominal distension from an unusual cause is given by Gervis.[8] The labor was difficult in consequence of the uterus of the child being greatly enlarged and containing about three-quarters of a pint of thin, flaky, serous fluid.

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[1] *Lond. Obstet. Soc. Trans.*, vol. xi.

[2] *Op. cit.*

[3] *Surgical Diseases of the Kidney.*

[4] *Lond. Obstet. Soc. Trans.*, vol. v.

[5] *Arch. f. Gyn.*, 1872.

[6] *Ibid.*, vol. ii.

[7] *Lond. Obstet. Soc. Trans.*, vol. xi.

[8] *Ibid.*, vol. v.

Enlarged liver has been the cause of dystocia, as in a case reported by Kilian[1] in 1854; in this case the forceps, and afterward the crotchet, were used in accomplishing delivery: the organ weighed two pounds and measured eight inches and three-quarters from side to side. Martin[2] has reported a similar case, in which the difficulty arose from enlargement of the pancreas, and Petit-Mangin[3] one in which the obstacle to delivery arose from hypertrophy of the spleen, ascites, and anasarca: the head presented, and after its extraction the chest was opened, and then an exit for the ascitic fluid was made by opening the diaphragm. In a case reported by Rogers[4] dystocia resulted from fibro-cystic disease of the undescended testicles.

Omphalocele—eventration, umbilical or abdominal hernia—is caused by an arrest of development, so that closure of the abdominal wall around the root of the cord does not take place, and some of the abdominal organs protrude, their covering being identical with the investment of the cord.

In the case of dystocia from this cause reported by Simpson[5] the fœtus presented the usual anomaly of attitude occurring in this form of arrest of development: anterior flexion of the body and members is replaced by a posterior flexion, the members being turned to the dorsal plane. It has been suggested that one cause of this abnormal attitude is that the weight of the abdominal viscera drags the dorsal spine forward. In the illustration (Fig. 296) of exomphalos associated with spina bifida this anomalous attitude is not present. If the intestines protrude very greatly, the obstetrician, feeling them projecting, it may be, from the os uteri, may for the moment think that rupture of the uterus has occurred, and that the mother's intestines have passed through the rent—an error that is readily corrected by partially drawing down the mass to the exterior. Delivery by podalic version is indicated if dystocia arises from exomphalos.

The tumor resulting from hydrorachis is rarely large enough to impede labor; if it is, puncture is plainly indicated. Porro,[6] however, has reported an instance in which the labor was delayed by hydrorachis associated with abdominal extrophy; the delay was ended by spontaneous rupture of the cyst. After the birth of the child the cyst was artificially filled, and found to contain 800 grams of fluid, and its maximum circumference was 37 centimeters.

In a difficult labor reported by Virchow[7] the head was delivered by forceps, and the body extracted as far as the lumbar region, when arrest occurred, which was found to be from a fluctuating tumor; this was opened by straight scissors and the delay was ended: the child lived fifteen hours.

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[1] See Hergott.

[2] *Monat. f. Geburt.*, vol. x.

[3] *Gaz. méd. de Paris.*

[4] *Am. Journ. Obstet.*, vol. ii.

[5] *Trans. Edinburgh Obstet. Soc.*, vol. vii.

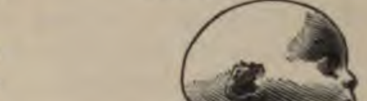
[6] *Arch. de Gyn.*, t. iii.

[7] *Gaz. méd.*, t. vi.

Mola[1] has collected 107 observations of tumors situated upon the lower portion of the trunk of the fœtus, and in only 18 were the labors thereby made difficult; 2 of the 18 were spontaneous, in 13 energetic traction was necessary to deliver, and in only 1 was the tumor punctured. These growths usually originate from the sacrum or the coccyx: in some instances they are so large that the child seems to be sitting on the tumor; in size they vary from that of a pullet's egg to that of a fœtal head at term, or they may be even still larger.

In a case under the obstetric care of Charpentier[2] the tumor became detached during podalic version and extraction of the fœtus, and, remaining in the uterine cavity, was mistaken for the membranes of a second child.

FIG. 299.



Sacral Tumor (Keller; Mütter Museum, College of Physicians).

The adjoined illustration is from a specimen in the Museum of the Philadelphia College of Physicians, the case having been reported by Dr. Keller.[3] Dr. K. first saw the child three days after delivery; in the labor the presentation was cranial; no difficulty occurred except in the extraction of the hips, and this was effected by the blunt hook, fracture of the thigh resulting from its use. Dr. K. stated: "When I examined the child I found a tumor of the size of a man's head attached to the nates, exactly behind the anal orifice, and containing a liquid. On the eighth day a puncture of the sac was made, and more than a quart of a brownish liquid escaped, which became of bloody color as it continued to flow. The child died a few hours after from a hemorrhage into the cyst." The doctor then states that, a post-mortem being made the next day, the viscera were all found in a healthy state, and did not communicate with the tumor; the sac was shrivelled into folds and contained a large clot of blood; it was a perfect cyst, the parietes of which were very dense, covered in some parts, particularly at its insertion in the nates, with soft conglomerations of blood-vessels.[1]

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[1] *Strasburg Thesis*, 1868. [2] Hergott. [3] *Trans. Path. Soc. Philada.*, vol. i.

Dr. Keller also reported at the same time a case of delivery being arrested by a similar tumor, the child having been expelled as far as the breech; he punctured the tumor with a curved trocar, and after the evacuation of about a gallon of a brownish liquid the sac was emptied and the child naturally expelled: it lived for six hours, dying from capillary hemorrhage into the sac.

In very rare instances ankyloses of the fœtal joints have prevented accommodation of the fœtus in labor, and thus interfered with labor; further, such rigidity of the fœtus may be an assisting cause of eclampsia in labor, the uterine irritation during contraction being thereby greatly increased. The only instance of such complete fœtal ankylosis met with by the writer many years ago presented the complication of convulsions in labor, and the eclamptic attacks were coincident with uterine contractions. Rigor mortis in the fœtus has been known to retard the progress of labor by preventing the flexion, rotation, and extension of the head as well as the movements of the body that occur when the mechanism of labor is normal. Two interesting cases of this sort have been recently described.[2] In one case the descent of the head was retarded, probably from insufficient flexion; in the other the head was arrested at the parturient outlet, probably from a failure of extension; in both cases some difficulty was experienced in the extraction of the body. The rigidity disappeared respectively one and three hours after birth. The same complication might present itself in a living child that had been subject to idiopathic "contracture" in utero.[3]

General œdema of the fœtus usually has associated with it ascites, and the latter rather than the former may be the cause of difficult labor, as in the case of Bassett. An emphysematous condition of the fœtus, provided it be dead, and great distension of the abdomen, each consequent upon decomposition, may so increase the size of the child that delivery is difficult. McClintock,[4] referring to the rapidity with which such decomposition may occur after the access of air to the dead fœtus, stated: "I have seen the uterus become quite tympanitic from this cause after the accession of labor and before delivery." Puncture is plainly indicated if the size be so increased from this cause that delivery is hindered: some interesting cases of distension of the fœtus following death have been recorded. In one of Smellie's[5] cases (278) this able accoucheur, failing to turn, delivered with the crotchet; there was difficulty in extracting the body, which was finally accomplished by opening the abdomen with the instrument: "the difficulty proceeded from the belly's being greatly tumefied after death."

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[1] *Op. cit.*

[2] Davidson: "Dystocia from Rigor Mortis in the Fœtus," *Br. Med. Journ.*, Jan. 2, 1886; and Boxall: "Arrested Labor from Rigor Mortis of Fœtus," *Lancet*, ii., 1884, p. 60.

[3] Ribemont-Dessaigne, abstract *Nouv. Arch. d'Obstét.*, 1887.

[4] Note to Sydenham Society's edition of *Smellie's Works*, vol. i. p. 127.

[5] *Op. cit.*, vol. ii.

Chassaignac[1] was called to a primipara, forty-one years of age, who had been three days in labor. Repeated applications of the forceps finally extracted the head, at the price of fractures and separations of several bones, but the body remained undelivered. Depaul, arriving, ascertained that the abdomen of the mother was greatly distended by the formation of gas in the uterus from decomposition of the fœtus. He applied the cephalotribe to the chest, reducing the size of the fœtus by strong compression and traction, a large quantity of fetid gas escaping; the thorax was brought down, and finally the rest of the body and the limbs extracted: the mother died in six hours. The fœtus was very large, the abdomen and thorax greatly distended, and the members doubled in size by infiltration of gas in the connective tissue.

In Lize's[2] monograph, entitled "Researches as to the Different Obstacles which Retain the Fœtus after the Head alone, or followed by a part of the Trunk, has escaped from the Vulvar Orifice during Labor," he states that in only 10 of the 56 cases he has analyzed was the obstacle maternal, and in 46 fœtal: in 38 instances the child died, but in only 4 the mother.

The delivery of some varieties of single monsters has already been given, and in regard to the remaining ones but little need be said. The pseudocephalus—a monstrosity which, though apparently acephalous, has nevertheless the cranial vault hidden in the fleshy part which forms the upper region of the body, uniting in a single cephalothoracic mass all the organs above the umbilicus—may, according to Geoffroy Saint-Hilaire, cause difficulty in labor. If such difficulty occur, podalic version or the application of the cephalotribe may be indicated. It has happened that the acardiac monster is so greatly developed, as in a case of Mayer's referred to by Schroeder, that embryotomy is necessary. Different varieties of acardiac monsters have been described; for example, the amorphus, that is, without form: in this there is neither head nor members, but a somewhat irregularly shaped spheroidal or cylindrical mass covered by skin, in the interior fleshy, with rudimentary pieces of bone, and blood-vessels imperfectly developed, and possibly rudimentary intestines: in the only example of this monstrosity the writer has seen the entire mass was not greater than a large white potato, and presented somewhat the same uneven surface. It is hardly possible that an amorphus can give rise to difficult labor. Another variety is the acormus, a monster without trunk, or the latter is only rudimentary.

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[1] *Journal de Chirurgie de Malgaigne*, 1845. Other examples of difficult labor from this cause will be found in "Merriman" and in "Denman."

[2] *Ann. de Gyn.*, t. xiii.

Charpentier[1] states that the anencephalus—that is, a fœtus without a brain—is often of remarkable development; there is frequently polyhydramnios also. The presentation may be of the base of the cranium or of the face, but in some cases of one of the shoulders or of the feet. Cazeaux, referring to the diagnosis of single monstrosities, remarks: "Anencephalous cases, however, present certain peculiar indications which it is of interest to know. Whenever the finger touches the presenting part the fœtus is affected with convulsive and irregular movements which soon attract attention, the motions being probably due to direct irritation of the stump, which is generally surmounted by the hairy scalp in cases of this kind. By this sign I was enabled to diagnose an anencephalous fœtus before the membranes were ruptured, to the great astonishment of the students at the hospital of the clinic where the labor occurred."

Villeneuve has reported a case of difficult labor from anencephalia; the following is the report: He was called by a midwife to a woman thirty-five years of age, in her fifth labor, thirteen hours after it began. Upon his first digital examination he believed there was a face presentation, but it was impossible to learn the position. A subsequent examination showed that the head was being pressed posteriorly and below in the pelvic cavity, while a hard round body tended to engage behind the right pubic bone; and this body was thought at first to be a second head, but a more careful examination proved it to be the shoulder. He applied forceps, and the head was thus delivered, though a reapplication of the instrument became necessary; there was great difficulty in delivering the body.[2]

Podalic version is indicated in such cases.

In regard to tumors resulting from what has been termed fœtal inclusion, these tumors being superficial or occupying one of the cavities—the abdominal is the most frequent seat—there is nothing special to be added to the treatment which has been given for growths similar in size and consistence obstructing delivery.

DYSTOCIA OCCURRING IN CASE OF SEPARATE, AND IN THAT OF CONJOINED, TWINS.—Plural pregnancies[3] rarely give rise to difficult labor when the fœtuses are not united, thus making a double monster. Nevertheless, in some instances of separate twins more or less serious difficulties have arisen in consequence of one twin interfering with the delivery of the other, and hence these anomalies are to be considered.

*Dystocia in Case of Separate Twins*—Besson[4] states that the predisposing causes to such obstacle to birth are the great size of the pelvis, the small size of the fœtuses, and their occupying one sac. Interference with the natural course of labor, as by premature rupture of the bag of waters or the untimely administration of ergot, has been regarded as determining the accident.

---

[1] *Traité pratique des Accouchements.*

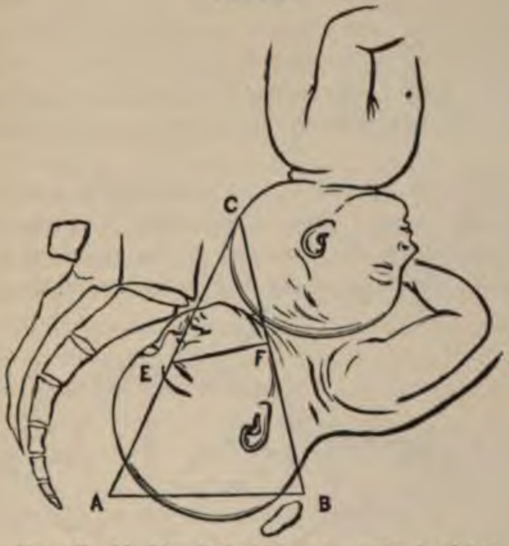
[2] Condensed from report in *Arch. méd. du Midi*, 1846.

[3] According to Braun, quoted by Zweifel, such difficulty occurs once in 90,000 labors.

[4] *Dystocie specielle dans les Accouchements multiples.*

No matter what the presentations, interlocking of the fœtuses may occur. In some instances—comparatively rare, however—the difficulty may be from both heads presenting simultaneously at the inlet: they cannot enter at the same time; one is in the way of the other. More frequently, as shown in the subjoined illustration from Barnes, one head descends into the pelvis, and the other, quickly following, is forced down, usually upon the neck of the other, and the further progress of each is arrested. The first head is delivered spontaneously or by the forceps, and then the arrest comes, or it may be before such delivery. In the illustration (Fig. 301), also taken from Barnes, the first child presenting by the pelvis and the second by the head, the former has been delivered, until arrest comes by the chin catching upon the chin of the latter.

FIG. 300.



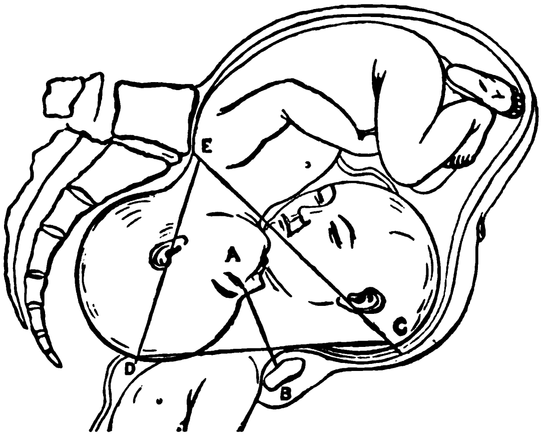
Shows Head-locking, both children presenting head first.

In some cases the head of the second child is fixed upon the thorax of the first. The locking of the heads may not be, as in the illustrations, by the chins, but by the occiputs or by a chin and occiput, or simply by the sides of the heads.

If both fœtuses present by the pelvis, difficulty may arise from the simultaneous descent of the lower limbs. In a case of such descent reported by Armand the midwife pulled so strongly upon the limbs that she brought away the bodies of the children, leaving the heads in the uterus. Schultze succeeded in delivering, in a case of labor with twins, four feet and one hand having descended, by drawing upon the two feet, which were the lower. Cazeaux quotes a case from Pleissman in which the latter, called to a woman in labor and finding that four feet had descended, thus causing locking of the pelves, succeeded in unlocking by having the woman's hips lifted up while her head was low: "The husband and brother-in-law of the woman passed their hands under her hams, and thus held her suspended, so that only the head and shoulders rested on the bolster. I intended, as soon as I mounted on the bed, to press back one or more of the free extremities into the womb, but two had already returned from the mere position of the mother, and the other three followed by the aid of my fingers. Immediately afterward I was enabled to introduce my hand into the uterus, and to withdraw successively therefrom three children by the feet."

The first child may present by the head, and the second be transverse, and locking occur. Thus Jacquemier[1] has narrated from the post-mortem examination the situation of the twins in a woman who died during labor: the head of the first fœtus was in the pelvic cavity, but its further descent had been stopped by the neck of the second child, which was below the shoulder of the first and formed a half ring. The first child may present by the pelvis, and the second be transverse, and difficulty occur, for the feet and the trunk may pass

FIG. 301.



Shows Head-locking, first child coming feet first; impaction of heads from wedging in brim; D, apex of wedge; E–C, base of wedge which cannot enter brim; A–B, line of decapitation to decompose wedge and enable head of second child to pass.

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[1] *Manuel des Accouchements*, t. ii. p. 131.

the obstructing body of the other, but the head be arrested. The last variety of obstruction given by Besson[1] is that in which the first child is transverse and the second presents by the pelvis. He quotes an illustrative case from Bartschler, in which two feet being found in the vagina, and delay occurring, exploration showed that the feet had descended, one on each side of the trunk of a second fœtus; that is, the first fœtus was *en cheval*.

The treatment of dystocia from interlocking of twins is—first endeavor by external and internal manipulations to unlock. We may imitate, if we fail while the woman is lying down, the plan of Pleissman, though not following his special method, but placing her in the genu-pectoral position; Galbraith succeeded in this way.

If we fail, some authorities advise forceps to the head of the second child (Fig. 301) or to that of the first (Fig. 300). In one instance strong traction upon the expelled limbs and body (Fig. 301) has drawn both heads through, but such an event is only possible if the heads are quite small and yielding. Considering now exclusively the latter condition of locking—that is, the body of one child expelled, the head of the other presenting—the application of forceps to the second head, made a rule by Reimann,[2] is condemned by both Barnes and Besson. The former wisely says that the first child, whose trunk is partly born, encounters by far the greater danger, and having discovered there is but a faint hope or no hope of saving it, attention should be turned to the best means of saving the second; the wedge may be decomposed by detaching the head of the first, or craniotomy be done. Besson advocates the same practice. Even Reimann admits decapitation of the first child if the application of the forceps to the head of the second is unsuccessful, and if the latter is living.

Now, in 34 cases collected by Besson where the first child presented by the pelvis, the second by the head, there were only 4 in which the former was born living. Such statistics prove more conclusively than any argument that consideration for its life is not an important element in determining the practice. Success, too, with forceps to the head of the second child can only be hoped for in conditions the same as those in which traction upon the body of the first child has accomplished delivery.

*Dystocia from United Twins.*—Veit in his elaborate paper[3] upon the management of labor in double monstrosities, in the beginning states that Hohl in 1850, from his collection[4] of cases scattered through the literature, arrived at the remarkable result that of 92 births of monstrosities belonging to congenital monstrosities *per defectum*, only 43

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[1] *Op. cit.*

[2] *American Journal of Obstetrics*, 1877.

[3] *Die Geburten missgestalterer, kranker und todter Kinder*, Halle, 1850.

[4] *Ueber die Leitung der Geburt bei Doppelmissgeburten.*

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Hohl's statement as to
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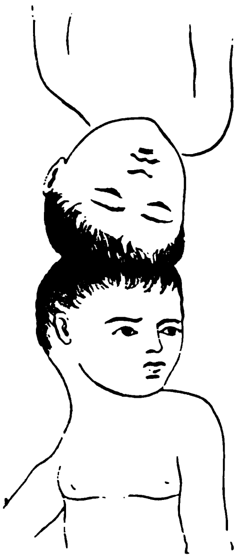
FIG. 302.



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difficulty in labor usually occur, for, though th
increased, the component parts of the monster

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[1] *Transactions of the London Obstetrical Society*, vol. viii.

[2] Playfair, apparently forgetting the more favorable stat
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[3] Veit.

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# DEX TO VOLUME I.

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Ischiopagus

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[1] In a brief poem
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  different, 657
  ether, 658
    exclusive use of, in certain localities, 658
    mixture of, with chloroform and alcohol, 659
  use in labor, 635, 636

being, terminated at each of its extremities by a thorax, two thoracic members, a neck, a head, and presenting in the middle portion a double abdomen, double abdominal members, and, quite at the centre, a common umbilicus. In the illustration presented herewith, copied from a cast in the Philadelphia College of Physicians, it will be seen that the lower limbs upon one side are fused together, making what is known in the separate fœtus a deformity characteristic of the symelia.

In Prunay's case of ischiopagus the twins, female, had club feet; they lived for several months. The chief point in the conduct of the labor is to prevent the four lower limbs being born together, but let each pair be born with the pelvis to which they belong.

*Dipygus* (*δις*, double, *πῦγή*, rump or buttocks—duplication of the posterior pelvic region of the body).—By the word polymelia, *πολῦς*, many, and *μελος*, member, is meant a monster characterized by one properly-developed fœtus, and a second one having its development limited to one or more members, which are inserted in the former.[1] In the pygomelia, one of the varieties of the class, the supplementary members are inserted between or behind the normal lower members. Pygomelia may therefore be taken as synonymous with dipygus.

Labor presents no difficulty unless in the delivery of the pelvis; in some instances the development of the supernumerary member or members is so slight that no serious obstacle results, and in most cases the fœtal pelvis is not so greatly developed that difficulty comes. If the pelvis presents, all the lower limbs should be brought down, and the same rule holds after version made in consequence of a transverse presentation. The dipygus or pygomelian monster is to be classed with the craniopagus and the ischiopagus, so far as delivery is concerned, in this regard, that the component parts of the monstrosity can be brought in the same line. In the only pygopagus I have seen, a negro child some two or three years old, there were two supernumerary lower limbs, but they were quite small even then, and could not have caused any difficulty in the labor.

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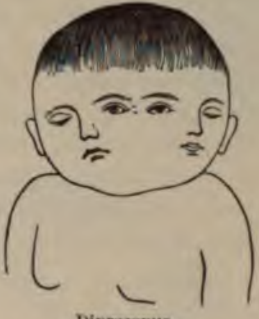
[1] Montaigne in one of his *Essays* (Hazlitt's translation, vol. ii. p. 510) describes a human monster which was fourteen months old when he saw it: after speaking in general of the child, he says: "Under the breast it was joined to another child, but without a head, and which had the spine of the back without motion, the rest entire; for, though it had one arm shorter than the other, it had been broken by accident at their birth; they were joined breast to breast and as if a lesser child sought to throw its arms about the neck of the one something bigger. The juncture and thickness of the place where they were conjoined was not above four fingers or thereabouts, so that if you thrust up the imperfect child you might see the navel of the other below it, and the joining was between the paps and the navel. The navel of the imperfect child could not be seen, but all the rest of the belly, so that all that was not joined of the imperfect one, as arms, buttocks, thighs, and legs, hung dangling upon the other, and might reach to the mid-leg." The description shows plainly that this monster was a heteradelphus, the least rare of the heterotypic variety of monsters in the human species. It is quite probable, too, that the presentation was pelvic, for only upon this hypothesis can a fracture of one of the arms at birth be best explained: ascension of this arm occurred, and in bringing it down it was broken.

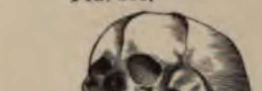
FIG. 304.



Diprosopus.

*Diprosopus* (from *δις*, double, and *προσωπον*, the face).—Examples of diprosopus, or a monster with a double face, are not frequent, Förster in 500 double monstrosities finding only 29 of this variety. The appended illustration shows one of the forms of this anomaly. Veit cautions against the danger of confounding a diprosopus, in case the head presents, with a hydrocephalic head; there is a larger number of sutures in the former, and in the latter the sutures are wider, the bones more flexible and thinner, and the rounding of their angles is more apparent. In this anomaly there is the same danger of rupture of the uterus as in the disease mentioned. Podalic version is not indicated, nor is the application of the forceps; but if the conjoined heads present great bulk, perforation and the cephalotribe may be required.

FIG. 305.



Deradelphus[2] (Mütter Museum, College of Physicians, Philada.).

*Monocephalus.*—In this monster a single head, without any exterior trace of duplicity, surmounts two bodies more or less intimately confounded and for a greater or less extent (Geoffroy Saint-Hilaire). If the trunks are united above and separate below the umbilicus, it receives the name of deradelphus and thoradelphus. The appended illustration of a deradelphic monocephalus is from a specimen placed in the museum of the College of Physicians by Dr. Warrington.[1] The woman who gave birth was a multipara, and was taken in labor about the time of the supposed end of her pregnancy, and Dr. Warrington's pupil, Dr. J. Pembroke Thorn, of Stevensburg, Va., was sent for to attend her. Dr. T. shortly after his arrival found four feet presenting in the vagina, and, thinking they belonged to separate twins, endeavored to push up two of them; in this effort he failed, and so did Dr. Warrington, who was called by Dr. T. when this difficulty was manifested. Then traction was made upon all four of the lower limbs, and delivery was made.

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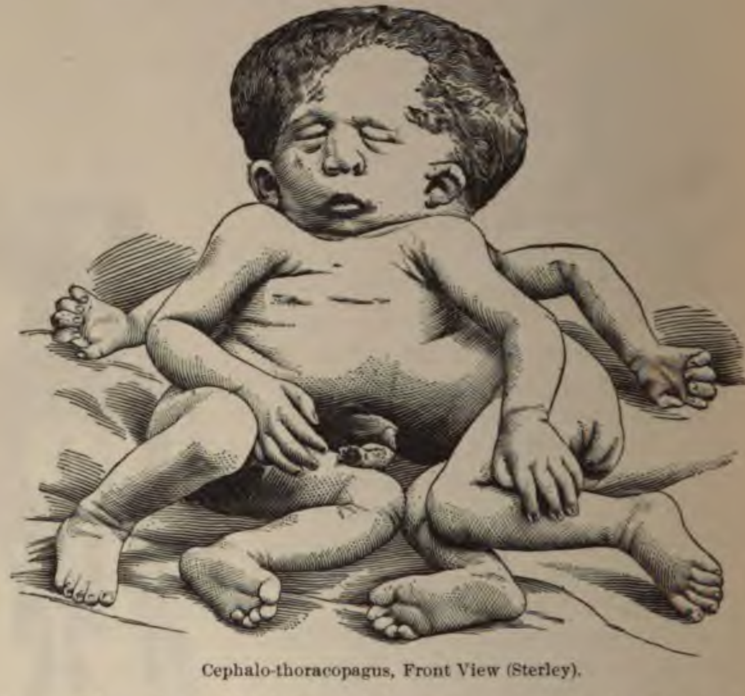
[1] *Summary of the Transactions of the College of Physicians*, vol. i., New Series.

[2] The name is from *δερή*, neck, and *ἀδελφος*, brother.

*Cephalo-thoracopagus.*—Figs. 306 and 307[1] are front and side views of a monstrosity occurring in the practice of Dr. J. B. Sterley—now of Reading, Pa., then living in St. Mary's, Elk county—February 23, 1878. The mother was a German, eighteen years of age, and had borne a child before this pregnancy; the labor, which was thought a month premature, was protracted, the child living when it began, but dying during its course. The head presented and the delivery was spontaneous: the child weighed six pounds ten ounces. It was a "double female infant, united by head, neck, and thorax. Thoraces united by anterior surfaces. Union of head and neck in a manner to show a complete face with ears on one side; on the other two ears in juxtaposition, above which is a rudimentary eye. Limbs four in number, and normal."[2]

FIG. 306.



Cephalo-thoracopagus, Front View (Sterley).

Upon looking at the front view one might justly conclude that the monstrosity was a deradelphus, but the additional ears and eye observed in the side view negative this, for in the deradelphus there is a single head without supernumerary parts; and therefore it is correctly designated as a cephalo-thoracopagus.

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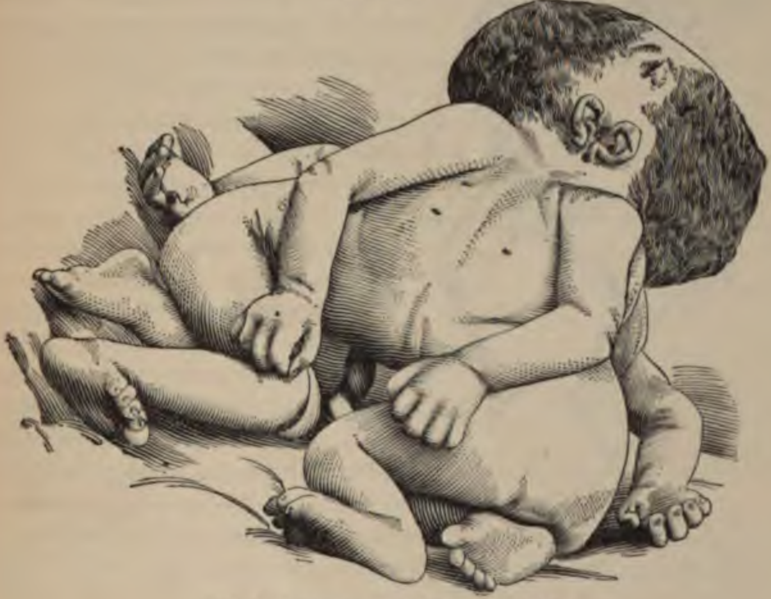
[1] I am indebted to Dr. C. R. Earley for the photographs from which these illustrations are taken, and to Dr. Sterley for kindly communicating some of the facts in regard to the labor, etc. not mentioned in connection with the specimen as recorded in the Catalogue of the Army Medical Museum, to which Dr. Sterley presented it.

[2] From description in Museum Catalogue.

The history of the labors in these last two cases shows that spontaneous delivery may occur either when the head presents or when the feet come first, for the traction used in the first, the case of deradelphus, was not probably more than a slight assistance to Nature's efforts; in other words, it is not essential to actively interfere, at least early in the labor, and, further, a resort to podalic version in case of cranial presentation in either variety is not positively indicated.

FIG. 307.



Cephalo-thoracopagus, Side View (Sterley).

*Derodymus.*—This term, derived from δερη, neck, and διδυμος, twin, is applied to a monster having two heads, two necks, a single body, and usually two lower and two upper limbs, though in some instances there may be additional members more or less rudimentary in development. One of the first-reported cases of derodymus is given by Peu.[1] In his history of the labor, which occurred on the 29th day of August, 1674, he states that two midwives had tortured the poor mother for hours endeavoring to extract the head of an infant which had half escaped from the internal mouth of the womb. Upon making an examination he found a second head, that the two heads were upon separate necks, and that there was only a single body. He performed version, brought down the body as far as the axillæ, then liberated the arms, after which he delivered first one and then the other head without rupturing anything. He adds, with charming frankness, if not with commendable modesty, "and this was the end of an operation equally beautiful and difficult that rescued the poor mother from shipwreck."

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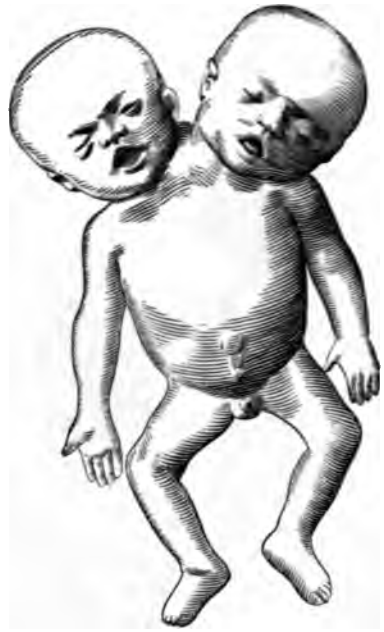
[1] *Op. cit.*

FIG. 308.



Derodymus (Mütter Museum, College of Physicians, Philadelphia).

Boerstler's case occurred in a woman in her ninth labor, and when called he found a pelvic presentation; further examination showed that there was a third lower limb firmly united to the body of the child and arising from the dorsum of the ilium; the delivery of the body and of the heads was accomplished without great difficulty; that of the latter could not have been effected but for the good fortune of the smaller head resting upon the neck and cheek, up to the malar bone, of the larger one. The monster[1] survived five weeks, during which time nursing[2] might be taking place on the part of one while the other was crying or sleeping. The third lower limb really consisted of two united limbs; that is, there was this resemblance to the symelian. In Pfeiffer's[3] case, credited by Playfair in his statistical table to Dr. Meigs, delivery of one of the heads occurred first, then of the body, and last of the second head.

Moore[4] reports a case of dicephalus monster causing dystocia. A head descending, he applied forceps, but failed to deliver. Then, recognizing that the difficulty came from a second head, he turned, and delivered. Fœtus nineteen and a half inches long and weighed eight and three-quarter pounds.

King[5] has recently reported a case of dicephalus, the woman having been in labor two days; the labor was premature, the woman a primipara. One of the heads presented, but attempts to deliver it with

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[1] The specimen is in the Museum of Jefferson Medical College. The case is reported by Dr. Boerstler in the *American Journal of the Medical Sciences*, vol. xxx., 1855.

[2] In the case reported by Facello, a tricephalus born alive and living for three days, the child sucked with all three mouths, and cried also with all three. (See Veit, *op. cit.*)

[3] *Meigs' Obstetrics*, 3d ed., p. 425.

[4] *Lancet*, June, 1882.

[5] "An Unusual Case of Monstrosity," by James K. King, Clifton Springs, New York, *Edinburgh Obstetrical Society's Transactions*, vol. xii.

Simpson's axis-traction forceps having failed, the presenting head was removed and delivery effected by podalic version and extraction. The monstrosity was nineteen inches long and weighed twelve pounds: the mother died three hours after delivery.

Two cases of dicephalous monsters are reported by both Playfair and Veit, in which decapitation was done, and then turning. The following observations by Veit are of interest in this connection: "If after decapitation podalic version appears a too dangerous operation for the mother, we will find that delivery by means of evisceration or of simple traction on the body is to a great extent rendered easy, as we have made room for hand and instruments. The repulsive impression made upon those present by decapitation is plain from the fact that Kleinwächter desires to more restrict the limit; but in a case of dicephalus dibrachius this operation removes a great obstacle, and the less the skill of the obstetrician the more necessary is decapitation before making an attempt at version. The case corresponds as to indications with those of absolute and relative contraction of the pelvis. The positive indication for Cæsarean section is, with reference to the obstetrician, a personal one. Whoever has the skill of Michaelis may still perform embryotomy with a conjugate of one and a half inches, while he who is less expert will do better for the mother if he selects Cæsarean section, even though the conjugate be two inches and a half."

In Hesse's case two applications of the forceps were made successively to the heads.

Veit remarks that in shoulder presentation the mother is quite as often saved by embryotomy as by version, and advises if the neck can be reached to perform decapitation, and if, as in most cases, the trunk is more accessible than the neck, eviscerate the thoracic and abdominal cavities, and extract with the hand, or according to Robert Lee, with the blunt hook.

It is evident from the narratives of cases that have been given that the delivery of a dicephalus may occur spontaneously whether one of the heads or the breech comes first; that traction with the forceps in the one case or with the hand in the other may be necessary; and, finally, that a spontaneous or artificial—that is, without mutilation—delivery may occur, unless the monstrosity be of great size or if there be an irreducible transverse presentation; and in either of the latter conditions embryotomy is required. The reduction of the size of the dicephalus required may be, as in King's case, by decapitation of the first head or by opening of the thoracic and abdominal cavities. Further, it seems to be well established that in case the heads come last their delivery is best effected by carrying the trunk well up over the mother's abdomen, "so as to cause the posterior head to pass first into the cavity of the pelvis," as Playfair directs.

*Xiphopagus.*—The Siamese Twins presented the best-known example of this variety of monstrosity. In regard to the delivery of these twins, one was born with the head, the other with the pelvis, presenting. Veit states that it is possible to develop the first child in a xiphopagus, the pelvis presenting, completely before the other child leaves the uterus, as was proved in a case taken by Kleinwächter from Jungmann's paper. Nevertheless, Schönfield[1] found it necessary in a case where one head presented, the other being at the ilium, to separate the children; the first child was then delivered with the forceps, and the second, which was transverse, by podalic version. But Schönfield's patient was a primipara, and the combined weight of the children was seventeen and a half pounds.

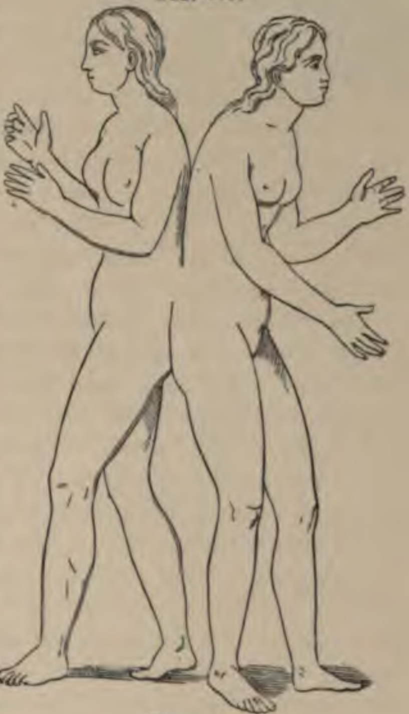
*Thoracopagus.*—Playfair,[2] who in his paper made four classes of monsters, included in the first "two nearly separate bodies united together in front to a varying extent by the thorax or abdomen." From a study of nineteen cases belonging to this class he formulated the following conclusion: "The most favorable presentation is undoubtedly that of the lower extremities, and if the head present and the nature of the monstrosity can be recognized, turning should be resorted to and the feet of both children brought down into the pelvis." Nevertheless, embryotomy may be necessary though the feet present. In a case[3] reported from Switzerland separation of the delivered trunk—at least delivered as far as the shoulder—from the head was necessary before the second child could be born. In Huron's[4] case the monster was delivered as far as the thorax, when embryotomy had to be done upon the first child. While, therefore, Playfair's rule may be accepted as wise practice, it ought also to be remembered that it gives no promise of certain success.

*Pygopagus* (from *πύγή*, buttocks, and *πηγνὺμι*, to unite).—This is a monster which, according to Saint-Hilaire, is composed of two individuals, each with an umbilicus, united in the region of the buttocks. Veit gives the following definition: Two complete individuals which only by the sacrum and by the coccyx, or only by the latter and adjacent soft parts, are connected. The most famous example of a pygopagus was that of the Hungarian Sisters, Judith and Helen, who lived to be twenty-three years old. At the birth of the Hungarian Sisters, Helen preceded with presentation of the head, and was delivered as far as the umbilicus; after three hours the lower portion of the body followed, and then Judith was born, her feet coming first. The pygopagus described by Normand was born in a similar manner. In the pygopagus of Jungmann, published by Kleinwächter, labor lasted twenty-one hours before the membranes ruptured, and again for eleven hours before the pains became strong; one hour later, after the midwife replaced

[1] See Veit's paper. [2] *Op. cit.* [3] Veit: *op. cit.* [4] *Ibid.*

a prolapsed arm, the head and arms were born, but the labor stopped when the body had passed out as far as the umbilicus. The midwife finally brought down the feet of the other child, and the delivery was soon completed. In Hochstetter's[1] case the labor occurred six weeks before the time. He found three feet presenting, and, failing to return one of these, he brought down the fourth foot, and succeeded in bringing out the monstrosity as far as the thorax. The arms were directed upward, and with great difficulty they were brought down, and then the extraction was completed.

FIG. 309.



Pygopagus.

In the management of labor in case of a pygopagus the obstetrician is without choice as to presentation, for version is probably impossible, and he must accept the presentation offered. The history of the first three cases would indicate that a presentation of the head of one of the twins was not unfavorable; and, indeed, when we see that in the fourth case, the feet presenting, the delivery of the twins must be simultaneous, it is evident that the pelvis and the entire birth-canal can only permit this passage if the twins are very small. Certainly, Playfair's law of podalic version is not indicated in the delivery of this variety of double monsters.

It is not necessary to refer to other monstrosities in their connection with dystocia. The fact that spontaneous delivery occurs in so many cases, one reason for which is that the labor is often premature, teaches the obstetrician not to be in haste to intervene; and the difficulty in many instances of knowing before delivery the kind of monstrosity will make him then cautious in the mode of intervention. Further, the Cæsarean operation is neither indicated nor justifiable in the delivery of a monstrosity.

DYSTOCIA FROM ANOMALIES OF THE FŒTAL APPENDAGES.—Adhesions of the fœtus to the placenta or to the membranes have in rare instances caused difficulty in labor, requiring in some artificial breaking of the adhesions, and in others the fœtus and its appendages have been expelled together. Malformation of the child, possibly to such a degree that it becomes monstrous, is frequently observed in these cases. Charvet[1] has described a cebocephalus in which there was adherence of the placenta to the cranium and the face.

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[1] Veit: *op. cit.*

Unusual thinness of the membranes permits their early rupture, and thus premature escape of the amniotic liquor, and from this delay in the dilatation of the os uteri results. If the membranes are preternaturally thick, the membranes may remain entire after the bag of waters has fulfilled its purpose in labor. Generally, the rupture of the sac is readily effected by pressing against its most prominent portion with the end of the finger during a uterine contraction; if this should not succeed, similar pressure may be made with a uterine sound or probe, or the notched nail of the index finger employed in making a to-and-fro movement against the membranes, the nail being thus used as a saw.

The placenta may prolapse, even when it has occupied its normal site, in consequence of premature detachment, whether from trauma or other cause. The chief consequence of such detachment is grave hemorrhage, and therefore the treatment of this prolapse will be considered under another head. Abnormal adhesion of the placenta to the uterus may be the consequence of placentitis, possibly having its origin in an endometritis present when pregnancy began; this condition is not frequent, and rarely involves the entire uterine surface of the placenta; if the latter be the case, a partial detachment of the placenta occurs, and hemorrhage is the necessary consequence: hence its treatment will be considered elsewhere. Decidual endometritis at other points of the endometrium than that which is the placental site may result in adhesions of the membranes to the uterine wall; the same inflammatory process that causes preternatural adherence of the decidua to the uterine wall causes adhesion between the decidua and the chorion. Pain resulting from this inflammation during pregnancy does not enable us to recognize the presence of decidual endometritis, and this recognition can only be made during the expulsion of the placenta. The placenta may spontaneously or as the consequence of uterine expression enter the vagina, or even emerge from it, but upon attempting to remove it it is found retained by attached membranes. In other instances the placenta is kept in position, though detached, by adhesions of adjacent membranes to the uterine wall. Finally, adherences may exist on the part of the placenta as well as of the membranes. In the first of these conditions, as described by Kormann, probably in the majority of cases sufficient time has not been given for normal retraction of the uterus, by which detachment of the membranes is effected, to occur, but too great haste, either by expression or by traction upon the cord, has been made to deliver the placenta. The method commonly used, should the placenta descend into the vagina, the membranes remaining in the uterus, is to detach them by turning the placenta around two or three times, thus twisting the membranes into a rope, and then withdrawing them. But if detachment cannot be thus effected, the introduction of the hand into the uterus is necessary, and then the fingers are used directly to detach and separate the adhesions. However, manual detachment of the membranes is usually rendered necessary only in those cases in which similar separation of the placenta is required; and as that must be considered in connection with post-partum hemorrhage, nothing more in reference to the former will be said now.

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[1] *Cebocephalie*, by Dr. A. Charvet, Grenoble, 1874. The family of cyclocephalians comprises five varieties—viz., ethmocephalus, cebocephalus, rhinocephalus, cyclocephalus, and stomocephalus. There is in the Museum of Jefferson Medical College a perfect specimen of rhinocephalus which I hope to describe at an early day.

Excess of the amniotic fluid, producing great distension of the uterus, as a cause of delay in labor, has previously been considered.

Anomalies relating to the umbilical cord are the most frequent in the class of anomalies of the fœtal appendages causing dystocia. While the umbilical cord usually measures from eighteen to twenty inches, Napier[1] states that it may be from two to seventy inches long; Dr. Matthews Duncan,[2] however, asserts that we have not reliable accounts of very short cords; and Crosse discredits Davis' report of a cord two inches in length.

According to Baudelocque, the length varies from 20 to 22 inches; Tarnier gives the variation as from 17.7 to 22.8.

Tyler Smith exhibited to the Westminster Medical Society a cord which measured 59½ inches; Negebauer saw one which measured 67¾ inches; and Cazeaux cites from Schneider one 3 meters in length.

Chantreuil,[3] in referring to the brevity of the cord, makes the following statement: "The shortest cord which Devilliers has seen was 11 inches; Reil and Meissner have each seen a cord of 5 inches. Of 12,303 cords measured in the clinic of Prague, the shortest was 4 inches. Malgouyré has seen one 2½ inches."[4]

Duncan mentions in the same paper from which we have quoted instances in which the cord was six, seven, and ten inches as examples of absolute shortness.

So far as increased length of the cord is concerned, such increase predisposes to prolapse of the cord and to the formation of circumvolutions around the child or its members, in some instances these coils making the cord relatively shorter, while absolutely it is longer than normal; and thus if either condition be present dystocia may result, for this has happened either in relative or absolute shortening of the cord; the difficulty is increased by the cord passing between the thighs of the fœtus in a pelvic presentation, as in the case reported by Bell,[1] in which the cord measured twelve inches, the child straddling it or being *à cheval* with reference to it. Depaul in a similar case, the cord being between the thighs and very tense, divided the cord; delivery soon followed, the pains being aided by traction.

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[1] *Transactions of the Edinburgh Obstetrical Society*, vol. viii.

[2] *London Obstetrical Society's Transactions*, vol. xxiii.

[3] *Des Dispositions du Cordon qui peuvent troubler la narche régulière de la Grossesse et de la Accouchement*, Paris, 1875.

[4] Chantreuil: *op. cit.*

Disturbance in the first stage of labor from shortness of the cord, whether absolute or relative, even though it measure but a few inches, is hardly probable, for, as pointed out by Duncan, advance of the uterine insertion occurs with the advance of the fœtal attachment; "during all the progress of the fœtus through the genital canal the uterine insertion of the cord is also progressing." So too, and for like reason, prior to the birth of the head difficulty cannot arise unless the cord be very short. Nevertheless, certain signs observed in the second stage of labor have been regarded as furnishing more or less clear indications of shortness of the cord. The labor is protracted without other obvious cause; a depression in the uterus is felt near or at the fundus—corresponding, as is supposed, with the placental site—occurring during a uterine contraction, and the woman experiences severe pain at this point; and the presenting head, for example, quickly recedes with the end of a uterine contraction, such contraction usually being briefer in duration than normal, and suddenly ceasing. Napier regards uterine inertia as a most important symptom of abbreviation of the cord: in his paper, however, he only refers to this diminution as resulting from coils about the neck of the fœtus.

Roederer, Leroux, and Levret have spoken of hemorrhage following such uterine contraction, this being caused by detachment of the placenta: as one of the signs, Winckel has mentioned elevation of temperature.

Some observers have called attention to the failure of anterior rotation of the occiput in cases of brevity of the cord arising from circulars, but posterior rotation was observed; and Chantreuil attributes this deviation from the ordinary mechanism of labor to the fact that such rotation may have for its effect tightening the spiral about the child. But if the neck be encircled several times by the cord, an interference with flexion would result, and hence the ordinary rotation fails. Nevertheless, neither hypothesis explains the fact that posterior rotation frequently occurs not only where there is relative, but also in absolute, shortness of the cord. If the shortening be from such coils around the child's neck, and if after the head is born artificial means are not taken to relieve the tension of the cord, semi-revolution of the child around the cord as a centre—it is called evolution by Duncan, who probably first described it—takes place, so that the anterior surface is brought to look forward, and thus the tension is lessened by the removal of half of one of the circulars (coils) about the neck. Among the consequences of great shortness, absolute or relative, of the cord, are its rupture, premature detachment of the placenta, and uterine inversion.[1] Dryenfurth[2] has reported a case in which the cord was only about two inches long, and inversion of the uterus was the consequence. Rupture of the cord generally occurs about the middle portion, according to Chantreuil, but it may be torn at either extremity. In a case reported by Devilliers, instead of the cord rupturing it was entire; but a small portion of the placenta was torn away. The strength of the umbilical cord varies, but its ultimate tenacity, as established by the experiments of Duncan and Turnbull, "was on an average eight and a quarter pounds, the weakest cord requiring five and a half pounds, and the strongest fifteen pounds, to tear it across or to break it." If the lessened length be the result of circulars about the child's neck, it is possible it may perish from asphyxia.

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[1] *Memorabil.*, 1882.

Negrier and Pfannkuch have shown that if the cord be varicose it ruptures more readily than in the absence of this condition. 5250 grams was the mean weight required to break a non-varicose cord, but only 3000 grams for a varicose cord.

If the diagnosis of a short cord be made during the second stage of labor, it is generally advised to press the fundus of the uterus downward, thus endeavoring to bring the placental insertion nearer the fœtal. The use of forceps to deliver the delayed head may be required, but a resort to instrumental delivery in all cases of supposed brevity of the cord, a positive diagnosis prior to delivery of the head being impossible, is not indicated. In a case reported by Braxton Hicks[3] delay in the delivery of the second of twins being caused by absolute shortness of the cord—it was only four inches long—its division was made within the vagina: the child was, however, already dead. Burton in two cases of prolonged labor from brevity of the cord divided the latter with his finger-nails.

The retraction of the head immediately after a uterine pain, to which several authors have drawn attention as one of the symptoms of brevity of the cord, Peu[4] sought to prevent by pressure with the fingers in the rectum—an obstetric method with which most associate the name of Smellie. The statement of Peu is: "Introducing my fingers into the anus as far in front as possible, I used them at the return of pains to push the head and make it descend as low as I could, and to keep it there, thus preventing its ascending, as it previously had done."

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[1] In a case reported by Levret all of these accidents happened: the child was expelled while the mother was standing, and was killed by falling on the floor, but the full uterus and placenta were dragged out and the umbilical cord broken.

[2] *Centralb. für Gyn.*, 1885.

[3] *Transactions of the London Obstetrical Society*, vol. xxiii.

[4] *Op. cit*

Smellie,[1] in his directions, "How to Behave when the Birth is Obstructed by the Navel-string of the Child or a Narrow Pelvis," observes: "When the head is therefore drawn back by any of these obstacles, and the delivery hath been retarded during several pains, one or two fingers, being introduced into the rectum before the pain goes off, ought to press upon the forehead of the child at the root of the nose, great care being taken to avoid the eyes: this pressure detains the head till the return of another pain, which will squeeze it farther down, while the fingers, pushing slowly and gradually, turn the forehead half round outward and half round upward. By this assistance and the help of strong pains the child will be forced along, although the neck be entangled in the navel-string; for as the child advances the uterus contracts, and consequently the placenta is moved lower; the funis umbilicalis will also stretch a little, without obstructing the circulation." In regard to the amount of stretching of the cord possible, it may be added that, according to Pfannkuch's experiments, this is half its original length.

In relative shortness from the cord being coiled about the neck, delay occurring after the birth of the head, we may endeavor to slip one or more coils over the head or extend them so that the shoulders can pass through, and thus at once relieve the tension of the cord and remove the peril of the child; if neither be possible—and of course such impossibility is present if there be material shortening of the cord—then the cord should be divided.

The umbilical cord is said to present when, the membranes being unruptured, it is felt along with the presenting part of the fœtus; but if after the rupture of the membranes it descends into the vagina, the condition is called prolapse, and distinguished as complete if the cord protrudes from the vagina. The distinction between presentation and prolapse of the cord is, so far as the terms are concerned, in some degree arbitrary; nevertheless, two different conditions exist, requiring different modes of treatment, and therefore the terms should be retained.

Prolapse of the cord is not infrequent, occurring once in about 225 labors. The causes are chiefly those which prevent the lower uterine segment from being completely occupied by the presenting part of the fœtus. Hence, this accident is not uncommon in case of a shoulder presentation or a flat pelvis; it is more frequent in presentation of the face or of the pelvis than in that of the cranium; it is not unusual in connection with prolapse of one of the members. It is observed oftener in multiparæ than in primiparæ; it is more liable to occur if the quantity of liquor amnii be great, especially if the amnial sac is ruptured while the woman is standing, or if the cord be abnormally long, or if the fœtus be very small. It is also facilitated by marginal attachment of the cord to the placenta, or by the latter being situated in the lower portion of the womb.

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[1] *Op. cit.* It is evident that the method, whether applied in this or other obstetric emergency, ought to be known as Peu's, and not Smellie's.

The DIAGNOSIS of presentation of the cord is usually difficult in the first part of dilatation of the os; but if the cord can be readily touched during an interval between uterine contractions, its characteristics will usually be recognized, for it has not the size, shape, or consistence of a prolapsed member, whether foot or hand, nor is it suddenly withdrawn, as one of these often is if touched: possibly by pressing it against a resisting part pulsation will be detected. The diagnosis of a prolapsed cord presents no great difficulty, and especially this prolapse cannot fail of ready recognition if pulsation is present. Presentation of the cord is not attended with any danger to the life of the child, for with unruptured membranes it cannot be pressed upon so as to interfere with the fœtal circulation; it is only a menace of prolapse which frequently brings such danger; nevertheless, it is probable that in most cases prolapse is averted by the descent of the head; for example, pressing away the cord and filling the space as it descends. But after the rupture of the amnial sac, should the cord descend in advance of the presenting part danger of compression between the latter and the walls of the birth-canal begins. The older obstetricians held that in complete prolapse danger came from that portion of the cord external to the vulva becoming cold, and hence coagulation of the blood resulted; indeed, Velpeau taught this, and even now Kormann states that in the presence of such a condition the cord should be enveloped with wet warm cloths and that it should be replaced in the vagina.

So long as there is merely presentation of the cord our chief object is to prevent its becoming a prolapse. Therefore every precaution must be taken to avoid premature rupture of the membranes: the woman should be recumbent, and preferably in such position that the part of the pelvis in which the cord presents shall be the highest, and thus if the cord be at the right side of the pelvis she will lie upon the left side of the body. If prolapse occurs, the presentation being that of the shoulder, podalic version is necessary in itself, so far as the interests of both mother and child are concerned, independently of the position occupied by the cord, and therefore the latter gives no special indication, except to reinforce the plan of treatment otherwise rendered essential. Presentation of the head gives the most dangerous prognosis in prolapsed cord, because the form and firmness of this part and the length of time required for its transmission render severe and continued compression of the cord more liable to occur. Nevertheless, even in this presentation, if the head be small, the pelvis roomy, and the labor-pains frequent and efficient, possibly assisted by a timely application of the forceps, delivery of a living child may often be accomplished. Meantime, the obstetrician in such a case carefully and frequently notes the condition of the cord as to pulsation, assisting his observations by auscultating the fœtal heart, and endeavors to place the cord in that position in the pelvis in which it will be least compressed. But in a case of vertex presentation, where no such prompt delivery can be reasonably expected, the cord must be placed above the presenting part or podalic version employed. The replacement of the funis does not present such great difficulty as the prevention of the recurrence of the prolapse; indeed, this recurrence is so common that some obstetricians have, in reference to repositing the cord, happily compared it to the task of the Danaïdes. The reposition of the cord may be manual, instrumental, or postural. Mauriceau directed that an effort be made to carry the cord by the fingers of one hand behind the head of the fœtus, and keep it there until the head had descended sufficiently to prevent it again prolapsing; he also added that a compress might be placed between the cord and head to prevent subsequent descent of the former. Other obstetricians have tried a sponge as a substitute for Mauriceau's compress. Success has been attained in some instances by hooking the cord over one of the fœtal members. Various repositors have been employed, some of them especially devised for the purpose, and others extemporaneous adaptations of bougie or of catheter. One of the oldest and best known means employed is making a bag into which a portion of the prolapsed cord is placed, and then the bag is attached to a piece of whalebone or a bougie, when the cord is thus carried above the head: as soon as the head descends the whalebone or bougie may be withdrawn. A repositor may be improvised of an ordinary firm rubber catheter and stylet with a piece of tape or cord. A loop of the tape is passed into the eye of the catheter, and the stylet then introduced, so that it holds the loop; the cord is fastened by the free ends of the tape, and then the catheter and cord carried into the uterus as far as necessary, when the stylet is withdrawn. Charpentier states that he has successfully employed the following method: The cord is encircled by a loop of silk and the ends tied, so that the former is held firmly, but not compressed; the ends of the silk are now fastened around the end of an olive-shaped or wax bougie; next the cord is thus carried in the uterine cavity so far that the lower end of the bougie is at the os. The bougie is left in the uterus, there is no tendency to recurrence of the prolapse, the instrument excites uterine contractions, and thus hastens the termination of the labor, which of course is always desirable.

Postural replacement of the cord by placing the woman in the knee-chest position was probably first proposed and employed by the famous Holland obstetrician, Deventer, and its advantages have in this country been especially made known by Thomas. Certainly in some cases the knee-chest position effectually remedies the displacement of the cord; but this result is more frequent if the cord simply presents than if it be actually prolapsed: moreover, the position must greatly hinder the progress of the labor if the woman occupies it during even a part of the second stage. In many instances where there are objections to the knee-chest position, as from the cause just mentioned, a lateral position may be employed, the woman of course lying upon the side opposite to that at which the prolapse occurs.

But the most important method of treating prolapse of the cord in a cephalic presentation, if a prompt delivery cannot be hoped for, is podalic version. Smellie said: "If the navel-string comes down by the side of the child's head and the pulsation is felt in the arteries, there is a necessity for turning without loss of time, for unless the head advances first and the delivery is quick the circulation in the vessels will be entirely obstructed and the child consequently perish. If the head is low in the pelvis, the forceps may be successfully used." McClintock, in a comment upon this passage, stated that of all the modes of treatment recommended, the most successful as regards the child is turning. "Thus of 64 cases in the practice of La Motte, Mauriceau, Lachapelle, Boivin, Giffard, and McClintock, when turning was resorted to solely on account of the funis presenting, 52 of the children were born alive." Of course if the child is dead prolapse of the cord does not offer any indication for interference.

Hemorrhage from the cord may result from its rupture in consequence of a velamentous insertion, the vessels being torn during the normal rupture of the membranes: this tearing necessarily occurs if these vessels occupy that portion of the fœtal sac nearest the os uteri. If this anomalous structure of the cord exist, and the blood-vessels occupy the position just mentioned, the diagnosis can be made during labor by recognizing the "pulsations of a vessel which may have the size of a crowquill," and precautionary measures may be tried to prevent early rupture of the membranes. Another diagnostic mark is hemorrhage at the time of the rupture of the membranes, the amnial fluid escaping, mixed with a large quantity of blood. If the vessels are torn and immediate delivery is impossible, the child perishes from anæmia. Even though rupture does not occur, the child's life may be endangered by asphyxia, for the vessels, instead of being torn, may be injuriously compressed.

Rupture of the cord from the child being born while the mother is standing, and falling to the floor, or even if she be delivered sitting and the cord is either relatively or absolutely short, is not usually followed by serious hemorrhage.

Coiling of the cord about the neck, body, or members of the fœtus is of significance in labor only as thereby shortening of the cord results, and hence dystocia; and as that topic has been considered, no further reference to such coils in the single fœtus will be referred to. But in case of twin pregnancy, the twins occupying a common amnial sac, the cord of one child may embrace some part of the other. Kormann states that hitherto only 12 cases of this accident have been observed: death of one or of both children may result.

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